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ASSOCIATION TENDENCIES AND LEARNING ABILITY

BY HULSEY CASON AND ELOISE BOEKER CASON

Syracuse University

1. INTRODUCTION

Our original purpose in this study was to measure individuality of response and learning ability, and determine the relation between them. Practically meaningless material was used in testing learning ability. No very satisfactory measure of the ability to make unusual reactions was available, but we used the Kent-Rosanoff 'free association' test [1] inasmuch as it is based on a large number of cases and has been studied under a variety of conditions. An attempt was made to analyze the various factors involved in this type of reaction since we hoped that such an analysis would afford a better understanding of the general nature of learning and of individuality of response.

The two experimenters used 100 students from their classes in general psychology as subjects. Since the experimenters (*H* and *E*) were of the opposite sex, and since each had subjects of both sexes, very good conditions were afforded for studying the effect of the sex of the experimenter on the behavior of the subjects in regard to individuality of response, reaction time, and learning ability.

[1] See G. H. Kent and A. J. Rosanoff, 'A Study of Association in Insanity,' *Amer. J. of Insanity*, 1910, 67, 37–96.

II. Procedure

The method to be employed was discussed at length before the experiment was begun, and the procedure used by the two experimenters was as nearly alike as can be reasonably obtained under ordinary circumstances by two different people. The sex of the experimenters, however, did influence the behavior of the subjects, and this matter is discussed in the section on results. The principal steps in the procedure are as follows:

1. The experimenter and subject were alone in a room free from distractions, and were seated at the opposite ends of a table.

2. *A. The Kent-Rosanoff Association Test.*—After attempting to get the subject in an easy relaxed position, he was given the usual instructions for taking the Kent-Rosanoff test, with special emphasis on the speed of reaction.

B. The subject was then practised on 12 words not found in the Kent-Rosanoff list, to determine how well he had understood the instructions. It was found that practically all subjects had some preconceived notion as to the particular kind of responses desired by the experimenter. Even with the most careful instructions, the responses are not entirely uncontrolled or free.

C. Instead of the customary ready signal before each of the Kent-Rosanoff words, we used the slight raising and lowering of the experimenter's head as the signal to get ready. The subject therefore coöperated better in the test, he did not let his eyes wander aimlessly about the room, and he knew just when the stimulus word was to be given. When the subject took as long as 5 sec. to respond, the trial was not counted. The words were repeated until a response had been obtained to each of the 100 stimulus words.

D. The time of the response was measured in fifths of a second by an ordinary stop watch, but with this difference from the customary procedure, that the watch ran continuously, and the stimulus word was given when the second hand reached a 5-sec. mark, and the position of the second hand on the dial was noted when the response was made. This method

seems not only to be more accurate than the one commonly used, but the subject is not distracted by hearing the watch when it is started or stopped.

3. *A. Speed and Accuracy of Learning.*—The next step in the procedure was concerned with measuring the subject's ability to learn practically unfamiliar material. We used 12 lists of 9 4-place nonsense words, each list being practically equal in difficulty. The subject was handed one of the lists typewritten on a card, and was instructed to learn the words in the proper order as quickly as possible, and to feel free to use any method he desired. When he thought he could just repeat the words of the list orally, he turned the card which he held in his hand face down on the table, and proceeded to repeat the list aloud without giving the experimenter any ready signal and without changing the general position of his body. Some preliminary experiments had shown that if the subject says, "Well, now I think I am ready," or sits up straight in his chair, or looks up at the experimenter, the situation is changed to some extent for him, and he cannot recite as well. These disturbing factors are also different for different subjects, and the procedure is improved by eliminating them almost entirely.

B. The first list of nonsense words was used for practise purposes only, to make sure that the subject understood what was expected of him. All subjects were required to learn at least 8 out of the 9 words in each list, and in the proper order. The presentation of the material was always visual, and the recitation was always oral.

C. After the preliminary practise on a single list, the subject was required to learn several lists until the total learning time was at least 600 sec. After a 3-min. rest period, this performance was repeated with additional lists, so that the total learning time was as nearly constant as possible for all subjects, being a little more than 20 min. in most cases.

D. Experimenter *H* also estimated the accuracy of learning for his 50 subjects. Although such an estimate is admittedly inaccurate, especially since all of the subjects were required to learn at least 8 of the 9 words in each list, the results seem to

show that this procedure affords a better measure of the efficiency of learning. In this method the experimenter simply gave credit for a fraction of a word if the word was not entirely correct.

4. All of the subjects were later given an Otis intelligence test, Advanced Examination: Form A. *H* gave this test to his students in groups, and *E* gave it to hers.

The procedure as outlined above, except for the Otis examination, lasted about 1 hr. for each subject. All of the subjects were taking their first course in psychology, and had not reached the chapters on association and memory in the textbook. All references to the principles involved in the experiment were avoided in lectures. The purpose of the above procedure was to examine association and learning tendencies under experimental conditions. Our results indicate that the performance on the Kent-Rosanoff test is definitely influenced by what may seem at the time to be only slight variations in the procedure.

III. Results and Discussion

1. *General Tendencies.*—Table I. shows the central tend-

Table I

General Tendencies of 50 Subjects (Experimenter *H*)

Variable	Average	S.D.	Range
1. No. of Responses With a Frequency of 0 (Kent-Rosanoff)	9.36±0.50	5.2	2–25
2. No. of Responses With Frequencies from 1 to 9 (Kent-Rosanoff)	14.32±0.61	6.4	2–37
3. No. of Responses With Frequencies from 0 to 9 (Kent-Rosanoff)	23.64±1.00	10.5	9–55
4. Weighted Score for Individuality of Response, Calculated from Responses with Frequencies from 0 to 9	894.16±42.27	443.1	370–2116
5. Time in Seconds Taken to Respond to Each of the 100 Kent-Rosanoff Words	1.52±0.03	0.4	0.92–2.53
6. Learning Time in Seconds per Syllable (Using Lists of 9 Nonsense Syllables Each)	24.03±1.16	12.2	8.1–73.0
7. No. of Syllables Wrong in Each List of 9 Nonsense Syllables	0.42±0.02	0.2	0.01–.90
8. Score on Otis Test (Advanced Examination: Form A)	178.50±1.68	17.6	138–208
9. Score on Test for Memory (No. 10) in Otis Test.	22.72±0.27	2.8	16–28
10. Age in Months	250.52±2.91	30.5	212–384

ency, variability, and range of *H*'s 50 subjects in the functions studied. Item 1 in the table shows the average number of responses not found in the Kent-Rosanoff frequency tables. This value of 9.36 is about what would be expected for college students, but the range from 2 to 25 is rather wide. The ranges are also significant in items 2 and 3. In estimating the individuality of a subject's responses, it is clear from just these data that the number of responses with a frequency of 0 will tell only part of the story.

In the Kent-Rosanoff tables, there is a considerable logical difference between responses with a frequency of 0 and those with frequencies of 2 or 3; but not nearly as much difference between responses with frequencies of 7, 8, and 9. The responses with frequencies above 9 seem quite natural, and not indicative of any great peculiarity of response. We have therefore used only those responses with frequencies from 0 to 9 to secure a measure of the individuality of a subject's response. The reactions with these frequencies were arbitrarily weighted as follows:

Frequency (Kent-Rosanoff Tables)	Arbitrary Weight Assigned
0	55
1	46
2	38
3	31
4	25
5	20
6	16
7	13
8	11
9	10

By using this scale (which has some logical justification), a weighted score for individuality of response was obtained, and this is shown in item 4 of Table I. It seems to be fairly clear that the measure of individuality of response thus obtained is not an adequate measure of individuality in general, since a person might be very individual in his association responses but fairly normal in several other respects.

The average reaction time in free association is shown in item 5 of Table I. We see that the average speed and the

average accuracy of learning for a given subject likewise vary rather widely. In test 10 of the Otis intelligence test (item 9), a simple story is read aloud, and the group being tested is later asked questions about it. In this test there is a possible score of 30. It will be seen that all of the distributions in Table I. are definitely skewed except accuracy of learning (item 7), the Otis score (item 8), and the test for memory (item 9).

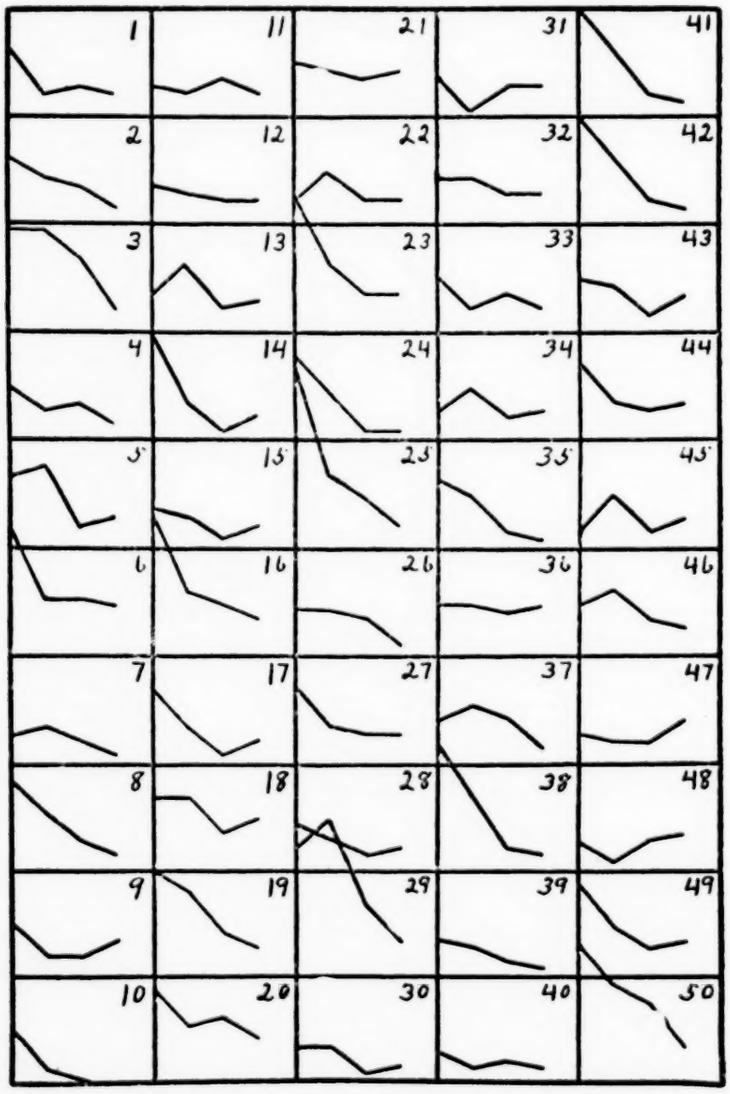

FIG. 1. Distribution of responses with frequencies according to Kent and Rosanoff of less than 1 per cent. (Experimenter *H*). The numbers in the figure designate the different subjects.

2. *Individual Responses.*—In using the Kent-Rosanoff tables for diagnostic purposes, the customary procedure has

been to take account principally of the number of responses with a frequency of 0. This method seems faulty, however, since it overlooks the marked irregularities at the lower end of the scale for several individuals. The distribution of responses with frequencies from 0 to 9 are shown in Figs. 1 and 2. The left-hand point on the curve for each subject repre-

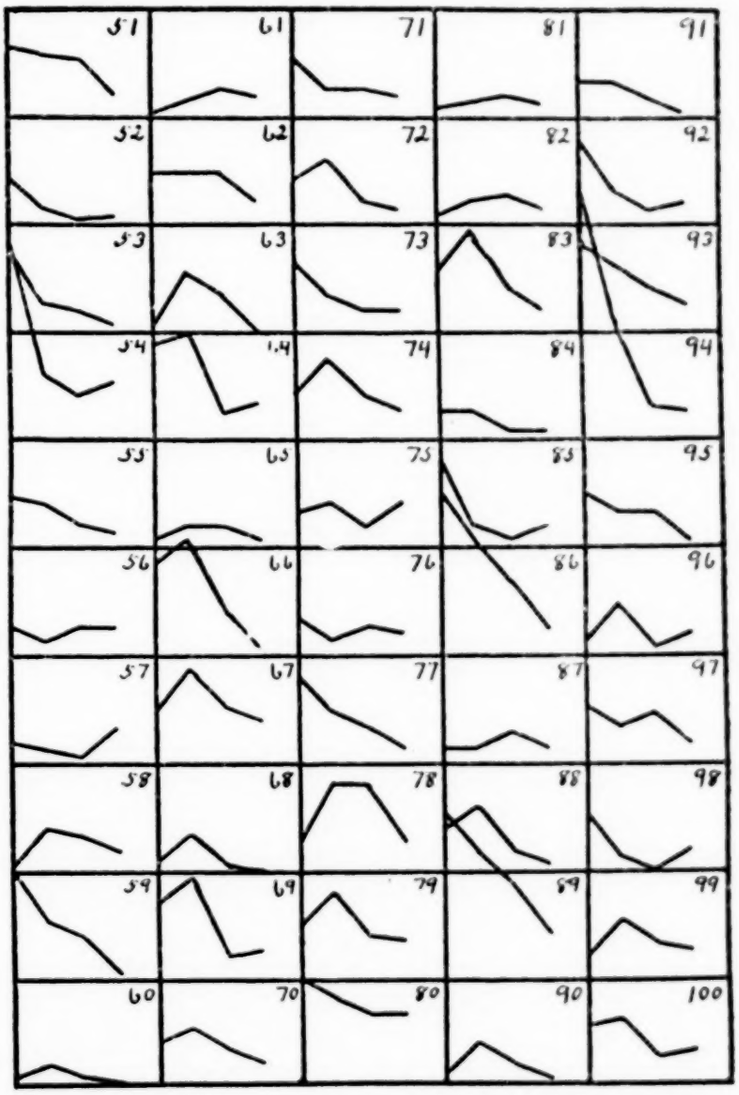

FIG. 2. Distribution of responses with frequencies according to Kent and Rosanoff of less than 1 per cent. (Experimenter *E*). The numbers in the figure designate the different subjects.

sents the number of responses with a frequency of 0 (1 mm. on the *y*-axis for each response), the second point the number of responses with frequencies from 1 to 3 inclusive, the third

point the number with frequencies from 4 to 6, and the right-hand point on the curve the number of responses with frequencies from 7 to 9. The curves are seen to be of many different shapes. If the curve is very high at the left, there will be a tendency for it to be low at the right since fewer cases would remain out of 100.

Fig. 3 represents the average number of responses obtained

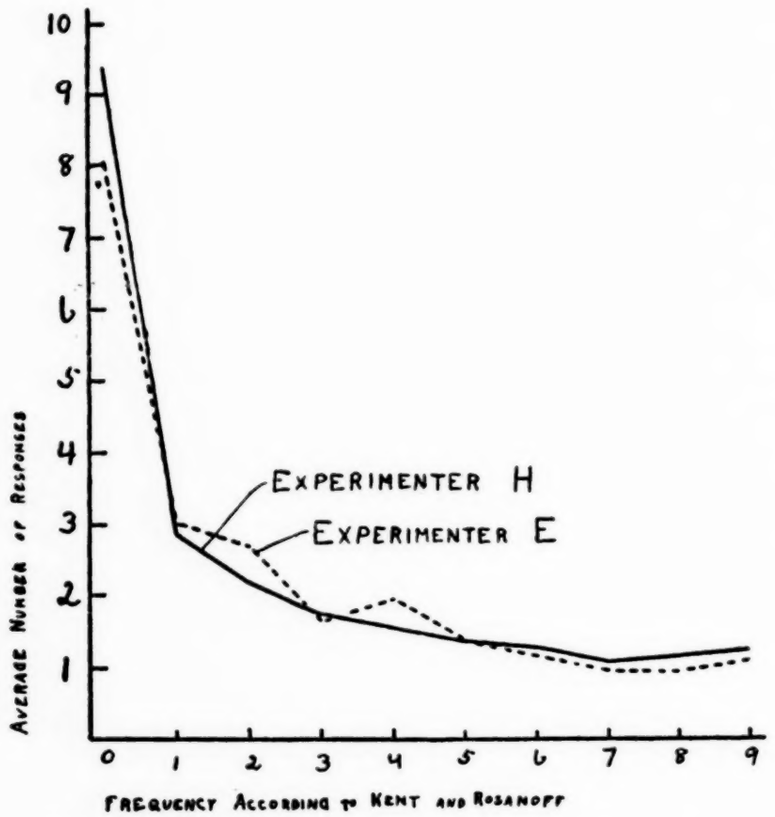

FIG. 3. Distribution of responses with frequencies according to Kent and Rosanoff of less than 1 per cent.

by both experimenters corresponding to each frequency from 0 to 9. The curves are seen to drop rapidly at the left, then more gradually, and they go up slightly at the right end. It is probable that if a much larger number of subjects were used the curves would cross once at some point between 4 and 5.

3. *Distribution of Responses.*—Fig. 4 shows the distribution of response frequencies for all of the male subjects tested by *H*, and also for an equal number of women selected at random. A little more than a third of the responses for either sex have

frequencies less than 40, but only about 1 per cent. have frequencies greater than 480. The average results for distribution of response for the two sexes are very similar. The

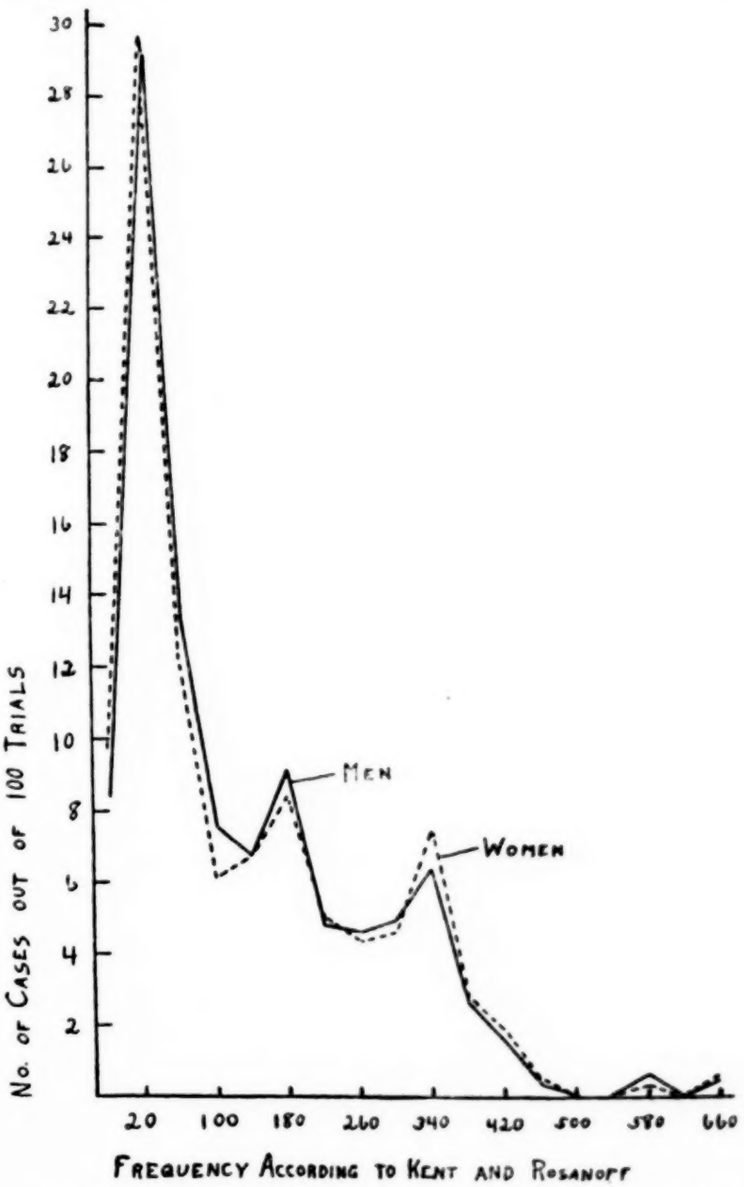

Fig. 4. Distribution of responses according to Kent and Rosanoff (Experimenter *H*).

presence of the two elevations above frequencies of 180 and 340 in the curves for both sexes seems to be due to the nature of the stimulus words themselves rather than to any unusual type of response in the 28 subjects which Fig. 4 represents.

4. *Reaction Time in 'Free' Association.*—The average re-

action times of the same 28 subjects are shown in Fig. 5. The general shapes of the curves are the same for both sexes, and the apparent differences are not reliable. For all practical purposes, it would seem that 4 sec. is enough time to allow for the response in the Kent-Rosanoff test, if speed is stressed in the instructions.

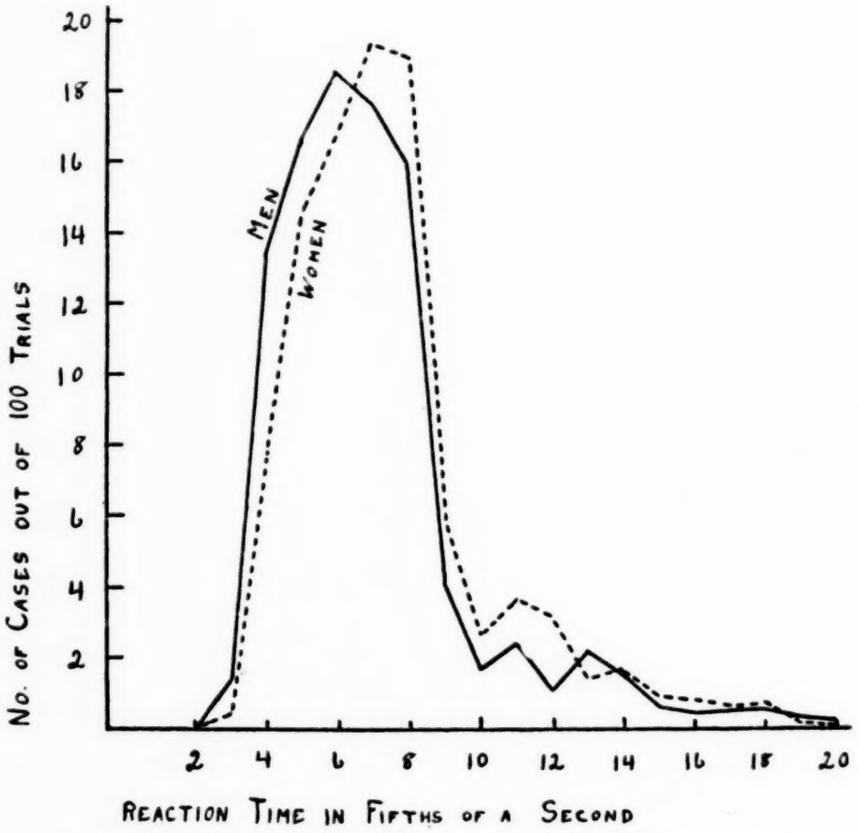

Fig. 5. Reaction time in 'free' association (Experimenter *H*).

5. *Correlations Between Different Subjects in Individuality and Speed of the Responses to the Kent-Rosanoff Words.*—It is apparent from the foregoing results that the Kent-Rosanoff Stimulus words themselves account for many of the irregularities which have been observed. An inspection of the Kent-Rosanoff frequency tables will show that some of their stimulus words yield much higher frequency values than others. To obtain a more accurate measure of these factors, we have made the calculations given in Table II. The middle column shows some correlations between the individuality of the responses to the Kent-Rosanoff words for the various pairs

TABLE II

CORRELATIONS BETWEEN DIFFERENT SUBJECTS IN INDIVIDUALITY AND SPEED OF THE RESPONSES TO THE KENT-ROSANOFF WORDS (EXPERIMENTER *II*)

Subjects		Correlation between the Individuality of the Responses to the Kent-Rosanoff Words for Pairs of Subjects	Correlation between the Speed of the Reactions to the Kent-Rosanoff Words for Pairs of Subjects
Male and Male	3 and 11	+ .17 ± .07	− .02 ± .07
	11 " 12	+ .30 ± .06	+ .21 ± .07
	12 " 15	+ .36 ± .06	+ .29 ± .06
	15 " 16	+ .04 ± .07	− .12 ± .07
	16 " 17	− .01 ± .07	− .20 ± .07
	17 " 33	+ .48 ± .05	+ .14 ± .07
	33 " 34	+ .54 ± .05	+ .20 ± .07
	34 " 35	+ .42 ± .06	+ .19 ± .07
	35 " 36	− .18 ± .07	+ .09 ± .07
	36 " 42	− .12 ± .07	− .06 ± .07
	42 " 44	+ .24 ± .07	+ .14 ± .07
	44 " 45	+ .16 ± .07	+ .18 ± .07
	45 " 47	+ .18 ± .07	+ .14 ± .07
	47 " 3	− .06 ± .07	− .02 ± .07
	Average	+ .18 ± .07	+ .08 ± .07
Female and Female	1 and 2	+ .15 ± .07	+ .20 ± .07
	2 " 4	+ .15 ± .07	+ .22 ± .06
	4 " 5	+ .28 ± .06	+ .17 ± .07
	5 " 6	+ .22 ± .07	+ .31 ± .06
	6 " 7	+ .11 ± .07	+ .01 ± .07
	7 " 8	+ .37 ± .06	+ .05 ± .07
	8 " 9	+ .29 ± .06	+ .25 ± .07
	9 " 10	+ .24 ± .07	+ .24 ± .07
	10 " 13	+ .15 ± .07	+ .23 ± .07
	13 " 14	+ .26 ± .07	+ .29 ± .06
	14 " 18	− .03 ± .07	+ .04 ± .07
	18 " 19	.00 ± .07	+ .13 ± .07
	19 " 20	+ .23 ± .07	+ .05 ± .07
	20 " 1	− .05 ± .07	+ .17 ± .07
	Average	+ .17 ± .07	+ .17 ± .07
Male and Female	3 and 1	+ .02 ± .07	+ .14 ± .07
	11 " 2	+ .33 ± .06	+ .29 ± .06
	12 " 4	+ .30 ± .06	+ .29 ± .06
	15 " 5	+ .20 ± .07	+ .31 ± .06
	16 " 6	+ .08 ± .07	+ .16 ± .07
	17 " 7	+ .26 ± .07	+ .30 ± .06
	33 " 8	+ .33 ± .06	− .01 ± .07
	34 " 9	+ .38 ± .06	+ .33 ± .06
	35 " 10	+ .32 ± .06	+ .18 ± .07
	36 " 13	− .01 ± .07	− .07 ± .07
	42 " 14	+ .34 ± .06	+ .23 ± .07
	44 " 18	+ .07 ± .07	+ .09 ± .07
	45 " 19	+ .07 ± .07	+ .06 ± .07
	47 " 20	+ .17 ± .07	+ .21 ± .07
	Average	+ .20 ± .07	+ .18 ± .07
Average		+ .18 ± .07	+ .14 ± .07

of subjects indicated in the left-hand column. These correlations range from − .18 to + .54, with an average at + .18 ± .07. The right-hand column of Table II. shows some correlations between the speed of the reactions to the Kent-Rosanoff words for various pairs of subjects. There is seen to be a slight tendency for some of the stimulus words to yield faster reaction times than others. These correlations range from − .20 to + .33, the average being + .14 ± .07. No marked sex differences are apparent in the correlations for either individuality or speed. The rank-difference method was used in computing these raw values, and since the distributions are not rectilinear all of the correlations should be larger than actually shown.

6. *Correlations Between the Individuality of Response and the Speed of Reaction to the Kent-Rosanoff Words for Individual Subjects* are shown in Table III. These raw values are consistently negative, and range from − .11 to − .59, the average being at − .33 ± .06. If the subject's reaction is delayed, it seems that associations which are more and more foreign to the original stimulus word are formed, and his response has less probability of being a common one. These results show

TABLE III

CORRELATION BETWEEN THE INDIVIDUALITY OF RESPONSE AND THE SPEED OF REACTION TO THE KENT-ROSANOFF WORDS FOR INDIVIDUAL SUBJECTS (EXPERIMENTER *H*)

Male Subjects	Value of *r*	Female Subjects	Value of *r*
3.....	− .22 ± .07	1.....	− .22 ± .07
11.....	− .45 ± .06	2.....	− .28 ± .06
12.....	− .19 ± .07	4.....	− .21 ± .07
15.....	− .24 ± .07	5.....	− .11 ± .07
16.....	− .23 ± .07	6.....	− .46 ± .06
17.....	− .44 ± .06	7.....	− .54 ± .05
33.....	− .51 ± .05	8.....	− .21 ± .07
34.....	− .47 ± .05	9.....	− .43 ± .06
35.....	− .52 ± .05	10.....	− .32 ± .06
36.....	− .32 ± .06	13.....	− .59 ± .05
42.....	− .29 ± .06	14.....	− .31 ± .06
44.....	− .25 ± .07	18.....	− .33 ± .06
45.....	− .28 ± .06	19.....	− .30 ± .06
47.....	− .32 ± .06	20.....	− .36 ± .06
Average	− .34 ± .06	Average	− .33 ± .06

very clearly the importance of the instructions in regard to speed of reaction in giving the Kent-Rosanoff test.

7. *Intercorrelations Between the Ten Variables.*—The product-moment formula was used in obtaining the raw correlations of Table IV.[1] A general survey has been made of these correlations to determine which can be raised by the partial correlation method, but in no case have we eliminated more than one variable at a time because of the considerable decrease in reliability which would have resulted.

The most significant correlations were obtained with speed of reaction to the Kent-Rosanoff words (see row 5 in Table IV.). This seems to be a significant result since so many writers have not considered it worth while to take the reaction time at all. Speed of reaction correlates $-.18$ with responses with a frequency of 0 (If the responses with frequencies from 1 to 9 are partialed out, however, the value for r becomes $-.75$). Speed of reaction correlates $-.52$ with frequencies from 1 to 9 (Partial out responses with a frequency of 0, and $r = -.82$; partial out accuracy of learning nonsense syllables, $r = -.67$; partial out age, $r = -.63$). Speed of reaction correlates $-.36$ with frequencies from 0 to 9 (Partial out accuracy of learning, $r = -.46$; partial out age, $r = -.44$). Speed of reaction correlates $-.29$ with the weighted score for individuality of response (Partial out accuracy of learning, $r = -.36$; partial out age, $r = -.34$). It should be noted here that speed of response correlates higher with frequencies from 1 to 9 than with frequencies of 0 or with the weighted score for individuality of response. As is frequently the case, weighting does not seem to raise the correlations materially. Although the r between responses with a frequency of 0 and frequencies from 1 to 9 is very reliable, being $+.62 \pm .06$, each of these variables interferes with the other in yielding a correlation with speed of reaction, and it appears that, in addition to the 0 responses, the 1 to 9 responses should also be used in interpreting the results of the Kent-Rosanoff test.

As might be inferred from the above discussion, the r between speed of reaction and accuracy of learning is also

[1] Table I. shows that most of these distributions are badly skewed, and end rather abruptly at the lower end. The correlations are also based on average figures.

TABLE IV

INTERCORRELATIONS BETWEEN THE 10 VARIABLES, BASED ON 50 SUBJECTS (EXPERIMENTER *II*)

	1. Responses with a Frequency of *0*	2. Responses with Frequencies from *1 to 9*	3. Responses with Frequencies from *0 to 9*	4. *Weighted Score* for Individuality of Response	5. *Speed of Reaction* to Kent-Rosanoff Words	6. *Speed of Learning*	7. *Accuracy of Learning*	8. *Otis Score*	9. *Memory* (No. 10, Otis Test)	10. *Age*
1. Responses with a Frequency of *0*		+.62±.06	+.88±.02	+.95±.01	−.18±.09	+.30±.09	+.09±.09	+.13±.09	0.00±.10	+.06±.09
2. Responses with Frequencies from *1 to 9*	+.62±.06		+.84±.03	+.88±.02	−.52±.07	+.13±.09	+.31±.09	+.12±.09	0.00±.10	+.21±.09
3. Responses with Frequencies from *0 to 9*	+.88±.02	+.84±.03		+.98±.00	−.36±.08	+.22±.09	+.23±.09	+.14±.09	+.01±.10	+.16±.09
4. *Weighted Score* for Individuality of Response	+.95±.01	+.88±.02	+.98±.00		−.29±.09	+.27±.09	+.18±.09	+.16±.09	0.00±.10	+.09±.09
5. *Speed of Reaction* to Kent-Rosanoff words	−.18±.09	−.52±.07	−.36±.08	−.29±.09		+.04±.09	−.29±.09	+.04±.09	+.18±.09	−.32±.09
6. *Speed of Learning*	+.30±.09	+.13±.09	+.22±.09	+.27±.09	+.04±.09		+.06±.09	+.28±.09	+.24±.09	−.20±.09
7. *Accuracy of Learning*	+.09±.09	+.31±.09	+.23±.09	+.18±.09	−.29±.09	+.06±.09		+.36±.08	+.10±.09	+.16±.09
8. *Otis Score*	+.13±.09	+.12±.09	+.14±.09	+.16±.09	+.04±.09	+.28±.09	+.36±.08		+.48±.07	−.29±.09
9. *Memory* (No. 10, Otis Test)	0.00±.10	0.00±.10	+.01±.10	0.00±.10	+.18±.09	+.24±.09	+.10±.09	+.48±.07		−.17±.09
10. *Age*	+.06±.09	+.21±.09	+.16±.09	+.09±.09	−.32±.09	−.20±.09	+.16±.09	−.29±.09	−.17±.09	

significant. This r comes to $-.29$ (Partial out frequencies from 1 to 9, $r = -.68$; partial out frequencies from 0 to 9, $r = -.41$; partial out weighted individuality score, or age, and $r = -.36$). The r between speed of reaction and age is $-.32$ (Partial out frequencies from 1 to 9, $r = -.51$; partial out frequencies from 0 to 9, $r = -.41$; partial out accuracy of learning, $r = -.39$). These calculations emphasize the claims previously made in this paper that the speed of reaction to the Kent-Rosanoff words is a factor which should be considered. In the relation between speed of reaction and individuality of response, accuracy of learning and age seem to be disturbing factors.

The correlations between *speed of learning* and individuality of response are not as high as we had expected to obtain, being $+.30$ with frequencies of 0, and $+.27$ with the weighted score for individuality of response. Speed of learning correlates $+.28$ with the Otis test. The r with age is $-.20$ (Partial out Otis test, $r = -.31$). The r between Otis score and age is $-.29$ (Partial out speed of learning, $r = -.37$).

The correlations between *accuracy of learning* and individuality of response are seen to be positive and small. Accuracy of learning correlates $-.29$ with speed of reaction, but $+.36$ with the Otis test (Partial out age, $r = +.43$). The r between accuracy of learning and age is $+.16$ (Partial out Otis test, $r = +.30$).

8. *Influence of Sex.*—We have already suggested that the sex of the experimenter may affect the performance on the Kent-Rosanoff test, and also influence some of the other functions studied. The influence of sex on average performance is represented in Tables V. and VI.; and the influence of sex on variability is shown in Tables VII. and VIII. We have made a calculation of the differences due to sex for 8 of the 10 variables of Table IV. Age was not considered because sex does not affect it, and no comparison could be made for accuracy of learning since it was not measured by experimenter *E*. Since only 14 men and 36 women were tested by *H*, and only 20 men and 30 women were tested by *E*, making a total of only 100 different subjects, it will be neces-

TABLE V

THE INFLUENCE OF SEX ON AVERAGE PERFORMANCES

Variable	1. No. of Responses with a Frequency of 0	2. No. of Responses with Frequencies from 1 to 9	3. No. of Responses with Frequencies from 0 to 9	4. Weighted Score for Individuality of Response
Experimenter Male (*H*)				
(*a*) Subjects Male				
Cases	14	14	14	14
Av.	8.21 ± 0.86	13.86 ± 0.93	22.07 ± 1.58	803.00 ± 70.38
(*b*) Subjects Female				
Cases	36	36	36	36
Av.	9.75 ± 0.60	14.50 ± 0.77	24.25 ± 1.21	929.64 ± 51.39
Diff. (M. Subjects–F. Subjects) with *Male* Experimenter, or *a–b*	− 1.54 ± 1.05	− 0.64 ± 1.21	− 2.18 ± 1.99	− 126.64 ± 87.15
Experimenter Female (*E*)				
(*c*) Subjects Male				
Cases	20	20	20	20
Av.	8.30 ± 0.77	15.70 ± 1.01	24.00 ± 1.55	923.10 ± 65.44
(*d*) Subjects Female				
Cases	30	30	30	30
Av.	7.83 ± 0.98	13.97 ± 0.93	21.80 ± 1.74	818.87 ± 77.45
Diff. (M. Subjects–F. Subjects) with *Female* Experimenter, or *c–d*	+ 0.47 ± 1.25	+ 1.73 ± 1.37	+ 2.20 ± 2.33	+ 104.23 ± 101.39
Effect of Having Experimenter and Subject the *Same* Sex (Same Sex–Opposite Sex), or (*a–b*)-(*c–d*)	− 2.01 ± 1.63	− 2.37 ± 1.83	− 4.38 ± 3.06	− 230.87 ± 133.66
Chances out of 100 that Sex of Experimenter will Affect Result in Direction Observed	79.71	80.88	83.28	87.84

TABLE VI

THE INFLUENCE OF SEX ON AVERAGE PERFORMANCES

Variable	5. Reaction Time (in Sec.) in 'Free' Association	6. Learning Time (in Sec.) per Nonsense Syllable	8. Score on Otis Test	9. Score on Test for Memory (Otis)
Experimenter Male (*H*)				
(*a*) Subjects Male				
Cases	14	14	14	14
Av.	1.50 ± 0.07	23.20 ± 1.48	173.93 ± 3.18	23.07 ± 0.49
(*b*) Subjects Female				
Cases	36	36	36	36
Av.	1.54 ± 0.04	24.35 ± 1.51	180.19 ± 1.94	22.58 ± 0.31
Diff. (M. Subjects–F. Subjects) with *Male* Experimenter, or *a–b*	− 0.04 ± 0.08	− 1.15 ± 2.11	− 6.26 ± 3.72	+ 0.49 ± 0.58
Experimenter Female (*E*)				
(*c*) Subjects Male				
Cases	20	20	20	20
Av.	2.24 ± 0.05	31.36 ± 2.30	174.30 ± 2.88	21.40 ± 0.44
(*d*) Subjects Female				
Cases	30	30	30	30
Av.	2.06 ± 0.05	26.33 ± 1.57	184.97 ± 1.69	21.47 ± 0.32
Diff. (M. Subjects–F. Subjects) with *Female* Experimenter, or *c–d*	+ 0.18 ± 0.07	+ 5.03 ± 2.78	− 10.67 ± 3.34	− 0.07 ± 0.54
Effect of Having Experimenter and Subject the *Same* Sex (Same Sex–Opposite Sex), or (*a–b*)–(*c–d*)	− 0.22 ± 0.11	− 6.18 ± 3.50	+ 4.41 ± 5.00	+ 0.56 ± 0.80
Chances out of 100 that Sex of Experimenter will Affect Result in Direction Observed	91.13	88.38	72.47	68.16

sary to consider all differences in connection with their reliabilities.

Inasmuch as the general form of Tables V., VI., VII., and VIII. is the same, the treatment of these results may be illustrated by reference to Table V. Under item 1 of this table we see that the 14 male subjects of experimenter *H* gave an average of 8.21 responses which are not found in the Kent-Rosanoff frequency tables. *H*'s female subjects averaged 9.75 responses with a frequency of 0—a sex difference therefore of -1.54 ± 1.05 when *H* was the experimenter. We are not justified in concluding that women will generally give a larger average number of individual responses than men; for the reverse was found to be the case when *E* was the experimenter. Her 20 men scored 8.30 responses with a frequency of 0, and her 30 women scored 7.83—making a sex difference of $+0.47 \pm 1.25$ when *E* was the experimenter. While we do not know the 'true' amount of the sex difference between the subjects in this function, we can obtain a measure of the influence of the sex of the experimenter on the behavior of the subjects by subtracting the two differences mentioned above, or $(a—b)—(c—d)$ in the table. If the experimenter and subject are of the same sex, it is seen that the subjects will give an average of 2.01 ± 1.63 fewer responses with a frequency of 0 than if the experimenter and subject are of the opposite sex.

If we consider Table V. as a whole, it will be seen that the sex differences between the subjects are not very reliable regardless of whether the experimenter is a man or a woman. We have more justification for concluding that when the experimenter and subject are of the same sex the subject will give fewer individual responses. We may recall that when the Kent-Rosanoff test was given the experimenter and subject were alone in a room with the door shut. (The reader may also be interested in knowing that the average age of the subjects was 22 years, as compared with 23 for female experimenter *E* and 31 for male experimenter *H*.)

According to Table VI. (item 5), there is no reliable sex difference between the subjects in reaction time when the experimenter is a man. If the experimenter is a woman,

TABLE VII

THE INFLUENCE OF SEX ON VARIABILITY

Variable	1. No. of Responses with a Frequency of 0	2. No. of Responses with Frequencies from 1 to 9	3. No. of Responses with Frequencies from 0 to 9	4. Weighted Score for Individuality of Response
Experimenter Male (*H*)				
(*a*) Subjects Male				
Cases	14	14	14	14
S. D.	4.77 ± 0.61	5.14 ± 0.66	8.77 ± 1.12	390.43 ± 49.76
(*b*) Subjects Female				
Cases	36	36	36	36
S. D.	5.32 ± 0.42	6.85 ± 0.54	10.80 ± 0.86	457.12 ± 36.34
Diff. (M. Subjects–F. Subjects) with *Male* Experimenter, or *a*–*b*	− 0.55 ± 0.74	− 1.71 ± 0.85	− 2.03 ± 1.41	− 66.69 ± 61.62
Experimenter Female (*E*)				
(*c*) Subjects Male				
Cases	20	20	20	20
S. D.	5.10 ± 0.54	6.69 ± 0.71	10.28 ± 1.10	433.86 ± 46.27
(*d*) Subjects Female				
Cases	30	30	30	30
S. D.	7.97 ± 0.69	7.53 ± 0.66	14.12 ± 1.23	628.89 ± 54.76
Diff. (M. Subjects–F. Subjects) with *Female* Experimenter, or *c*–*d*	− 2.87 ± 0.88	− 0.84 ± 0.97	− 3.84 ± 1.65	− 195.03 ± 71.69
Effect of Having Experimenter and Subject the *Same* Sex (Same Sex–Opposite Sex), or (*a*–*b*)–(*c*–*d*)	+ 2.32 ± 1.15	− 0.87 ± 1.29	+ 1.81 ± 2.17	+ 128.34 ± 94.53
Chances out of 100 that Sex of Experimenter will Affect Result in Direction Observed	91.28	67.54	71.31	82.01

TABLE VIII

THE INFLUENCE OF SEX ON VARIABILITY

Variable	5. Reaction Time (in Sec.) in 'Free' Association	6. Learning Time (in Sec.) per Nonsense Syllable	8. Score on Otis Test	9. Score on Test for Memory (Otis)
Experimenter Male (*H*)				
(*a*) Subjects Male				
Cases	14	14	14	14
S. D.	0.40 ± 0.05	8.23 ± 1.05	17.63 ± 2.25	2.71 ± 0.35
(*b*) Subjects Female				
Cases	36	36	36	36
S. D.	0.32 ± 0.03	13.39 ± 1.06	17.29 ± 1.37	2.77 ± 0.22
Diff. (M. Subjects–F. Subjects) with *Male* Experimenter, or *a–b*	+ 0.08 ± 0.06	− 5.16 ± 1.49	+ 0.34 ± 2.63	− 0.06 ± 0.41
Experimenter Female (*E*)				
(*c*) Subjects Male				
Cases	20	20	20	20
S. D.	0.36 ± 0.04	15.22 ± 1.62	19.09 ± 2.04	2.92 ± 0.31
(*d*) Subjects Female				
Cases	30	30	30	30
S. D.	0.44 ± 0.04	12.77 ± 1.11	13.76 ± 1.20	2.63 ± 0.23
Diff. (M. Subjects–F. Subjects) with *Female* Experimenter, or *c–d*	− 0.08 ± 0.06	+ 2.45 ± 1.96	+ 5.33 ± 2.37	+ 0.29 ± 0.39
Effect of Having Experimenter and Subject the *Same* Sex (Same Sex–Opposite Sex), or (*a–b*)-(*c–d*)	+ 0.16 ± 0.08	− 7.61 ± 2.47	− 4.99 ± 3.54	− 0.35 ± 0.57
Chances out of 100 that Sex of Experimenter will Affect Result in Direction Observed	91.13	98.11	82.77	66.06

however, the female subjects are somewhat faster on the average than the male. The conclusion is fairly reliable that the effect of having the experimenter and subject of the same sex is to speed up the subject's reactions. We see from the next column in the table (item 6) that the women slightly surpass the men in efficiency of learning, and that subjects will generally learn faster for an experimenter of the same sex.

In the Otis test (items 8 and 9, Table VI.), the relation between the experimenter and subject was not the same as in the other cases just discussed. When this test was given the subjects were in a group situation, and not alone with the experimenter in a closed room. As might be expected, the influence of the sex of the experimenter on the result is slight in this case. According to Table VIII. (items 8 and 9), however, it would seem that a group taking the Otis test will be somewhat less variable if the experimenter is of the same sex.

Table VII. shows that women are generally more variable than men in the number of individual responses which they give. The influence of the sex of the experimenter on the variability is irregular. Finally, it appears in Table VIII. (item 5) that the effect of having the experimenter and subject of the same sex is to increase the variability of the speed of reaction. In efficiency of learning, however, the variability is increased when the experimenter and subject are of the opposite sex.

9. *General Discussion of Results.*—Some writers have considered that the Kent-Rosanoff test is so simple that it can be given by most anyone without a great deal of care in regard to the experimental conditions. Kent and Rosanoff write that "No attempt is made to secure uniformity of external conditions for the test; the aim has been rather to make it so simple as to render strictly experimental conditions unnecessary." [1] We have shown, however, that the results on this test will vary considerably with what may seem at the time to be only slight changes in the procedure. The most important

[1] G. H. Kent and A. J. Rosanoff, 'A Study of Association in Insanity,' *Amer. J. of Insanity*, 1910, 67, p. 38.

of these factors seem to be the nature of the instructions in regard to speed of reaction and the sex of the experimenter. While simplicity is a desirable feature in any test, this particular test cannot be given well without paying a good deal of attention to the experimental conditions. Kent and Rosanoff, however, state that "This method is so simple that it requires but little training on the part of the experimenter, and but little coöperation on the part of the subject." [1]

We did not find any conclusive evidence to justify the claim made by Burt and Moore [2] that males definitely excel females in speed of reaction; but this may be due to the fact that their subjects were children.

IV. Conclusions

1. Practically all college students begin the Kent-Rosanoff test with some preconceived notions in regard to the particular kind of responses desired, and even with the most careful instructions the reactions are not entirely uncontrolled or free.

2. The correlations between the individuality of response and speed of reaction to the Kent-Rosanoff words for individual subjects range from $-.11$ to $-.59$, with an average of $-.33 \pm .06$. If the subject's reaction is delayed, responses which are more and more foreign to the original stimulus word are formed, and his response has less probability of being a common one. The frequency value of each response therefore tends to be a function of the speed of reaction.

3. There is a negative correlation between the *average* individuality of response and the *average* speed of reaction to the Kent-Rosanoff words for a group of subjects. If responses with frequencies from 1 to 9 are constant, speed of reaction correlates $-.75$ with responses with a frequency of 0. If responses with a frequency of 0 are constant, speed of reaction correlates $-.82$ with responses with frequencies from 1 to 9. A subject who is quick in reacting is therefore more likely to give common responses than one who reacts slowly.

[1] *Op. cit.*, 43.

[2] C. Burt and R. C. Moore, 'The Mental Differences between the Sexes,' *J. of Exper. Ped.*, 1912, 1, 273–284, 355–388.

4. In interpreting the results of the Kent-Rosanoff test, it is desirable to take account of the responses with frequencies from 1 to 9 as well as those with a frequency of 0.

5. The sex of the experimenter affects the subjects' performance on the Kent-Rosanoff and learning tests. When the subjects are in a group situation taking the Otis intelligence test, however, the influence of the sex of the experimenter is not as marked.

CORRELATIONS OF ACHIEVEMENT WITHIN AN INDIVIDUAL

BY H. L. HOLLINGWORTH

Columbia University

The performance scores of a single individual in a given task vary from moment to moment and from day to day. This is true even in the case of the expert, who has reached a practise limit in the act in question. Such variability from one's own average is, moreover, characteristic of every type of act or process. Is there any relation between the fluctuations in different processes, within an individual? Is the deviation of each record determined merely by the episodic conditions of its particular performance, and thus unrelated to the deviations manifested in other tasks? Or are all the deviations, or certain ones of them at least, determined in common by systemic factors, by general conditions of the organism?

We have heard much of the correlation of traits. But it seems that all correlations on record concern the relationship of traits when a group of individuals is concerned, the individual record being taken as a more or less accurate indication of the fairly constant status of the individual in the given function or act. In the present instance we inquire, instead, concerning the relationship between traits as these vary within the same individual from time to time. It is just possible that knowledge of the coherence of traits *within an individual* may be as instructive, for the general doctrine of the organization of mind, as is the establishment of relationships *among individuals*.

Clearly enough relationship of deviations can be made out within an individual, in so far as major determinants with a systemic influence are definitely operating, either to stimulate performance on a given occasion, or to retard it. Thus such factors as excitement, fatigue, sickness, practise, and intoxi-

cation may operate in such fashion that performances in a variety of tasks rise or fall together, thus producing a positive intra-individual correlation. With these obvious factors (whose influence is not however as simple as the description of their operation may suggest) we are not now concerned. Instead we are interested in those minor deviations that occur from time to time, when the conditions of general health, motivation, interest, and the like are as constant as it is possible to maintain them, when the general course of fatigue is avoided, and the changes due to practise improvement are so far as possible eliminated.

Six individuals submitted to measurement in a variety of simple tasks, working continuously for the hours of an ordinary working day, for a number of days. Every half hour the series of tasks was accomplished, and immediately thereupon began the next round of performances. After 40 trials the practise improvement in all of the processes was practically eliminated, and the forenoon trials of all days were made under conditions as constant as it was possible to produce. Six trials were thus made in each forenoon, for seven days, after forty practise trials had already been accomplished. The study of these 42 trials, in six processes, by six individuals, affords material for a study of the questions we have raised.

The tests no longer need description, for they are identical with the tasks frequently described by the writer in connection with other studies. Their familiar names, which will at once indicate their nature, are: Tapping, Steadiness, Three-hole Coördination, Color Naming, Substitution, and Pulse Rate. Fuller description is to be found in the writer's recent reports relating to the influence of alcohol.

For the determination of inter-correlation of tasks within an individual, the series of 42 trials were ranked for each task. By the Spearman rank method correlations were then computed between the records from time to time within the given individual, for each individual separately. The subjects were all male college students.

For the determination of stability coefficients, the first trials of each hour were used for one series and the second trials

of the corresponding hours for the second series. This gave a series of 21 trial pairs, which were correlated in the same way for each individual.

All stability coefficients are thus based on 21 pairs of cases, for each individual, and all inter-test correlations on 42 pairs for each individual. The probable errors of these coefficients can thus be known through reference to the appropriate statistical tables, and are not printed here. A special table is also given showing the degree of practise gain, which, although very slight, is still perceptibly present when the final trials of the series are compared with the earlier trials.

The Distribution of Individual Records

That the performances of a given individual distribute themselves about their central tendency in the 'normal' fashion is often taken for granted in psycho-physical studies. When this distribution occurs the various records of a single individual will be grouped just as are the single records of various individuals. It may be worth while noting to what degree, in the six measurements, our own data give this result, since it is far from obvious that the curve of distribution of an individual's performances will be symmetrical rather than skewed.

In Tapping, for example, the argument might be advanced that numerous influences might be detrimental to a momentary record, whereas fewer and smaller influences are available to raise the performance beyond the usual level. Or again, in Steadiness, there is no upper limit to the number of contacts possible, although the lower limit is definitely fixed at zero. Thus the Steadiness scores may range, in one direction, that of poorer performance, from the median level to infinity. But in the direction of superior performance they can vary only between zero and the median. With a median of 12 contacts the variations in the direction of greater steadiness can never exceed 12, but in the direction of unsteadiness no limit is set except by the mechanics of movement.

Obviously a distinction must be made between what is theoretically possible and what actually happens under the

conditions of an organised experiment, with adequate instruments and well intentioned subjects. It is the latter case that interests us—the condition that ordinarily confronts scientific investigation.

We have for each individual 42 trials in each of six processes. We may use as the measure of central tendency either the mean or the median. Using the mean, the direction and amount of skewness would be indicated by the number of records occurring above and below this mean. Or using the median, the magnitude of the deviations in the two directions would afford a similar indication. We have chosen to use the median and the median deviations above and below this measure.

In the following table there are given for each subject in each process the median record, and also the Q above and the Q below this Median. Equality of these Q's will suggest a symmetrical distribution. $Q1$ is the median deviation in the direction of better performance, except in Pulse, where it is the deviation toward higher rate. Thus $Q1 > Q2$ indicates deviations of greater magnitude in the direction of superior performance, while $Q1 < Q2$ indicates greater deviations in the direction of inferior work.

Considering the thirty-six comparisons given by the table, the results for the different relations of $Q1$ to $Q2$ are as follows:

$Q1$ greater than $Q2$	15 cases
$Q1$ less than $Q2$	16 cases
$Q1$ equal to $Q2$	5 cases

There is a clear balance of tendency in the long run, and the division of cases in the six different tests points in the same direction. In all the processes (except coördination, where the differences are slight) the cases are either evenly balanced or so nearly so that the shifting of a single case would balance them.

We must conclude that the data suggest very clearly that, under the conditions of such an experiment, the theoretical disparity of influences, making for loss and for gain, is not present. The definite tendency is for the records of an indi-

vidual to distribute themselves symmetrically about the central tendency of his performance, just as do the single records of different individuals chosen at random.

TABLE I

Subj.	Tapping		Coördination		Steadiness	
	Median	Q1 Q2	Median	Q1 Q2	Median	Q1 Q2
A.....	420	14 < 30	130	14 < 15	13	5 < 7
B.....	485	28 < 43	155	7 < 14	11	4 = 4
C.....	498	40 > 26	148	6 < 7	4	2 = 2
D.....	499	23 > 19	168	4 < 6	15	5 > 2
E.....	576	22 < 24	150	4 > 3	12	8 > 5
F.....	453	27 < 71	148	4 < 5	14	5 = 5

Subj.	Substitution		Color Naming		Pulse Rate	
	Median	Q1 Q2	Median	Q1 Q2	Median	Q1 Q2
A.....	75	11 > 7	56	5.4 < 11.8	73	7.6 > 3.6
B.....	95	5 < 9	49	2.7 > 1.7	67	3.0 < 3.4
C.....	85	8 < 10	52	1.9 < 2.3	59	6.6 > 3.4
D.....	103	7 = 7	46	2.8 > 1.2	59	4.3 > 3.3
E.....	124	8 > 7	43	1.8 > 1.2	80	4.0 = 4.0
F.....	120	9 > 6	41	1.6 < 3.0	68	3.6 > 2.0

This result justifies the application, to the records of an individual, of the same statistical methods as would be applied to the measurements of a group of individuals. Naturally, the magnitude of the deviations in the performance of an individual need not be expected to be so great as that for a group of subjects chosen entirely at random. But there is no present reason for supposing that even this magnitude will not closely resemble that in the case of a group of individuals of the same general class.

Data are in fact available for something like a comparison of this sort, in the records of Carothers's study of college freshmen. The average records are somewhat different from those of our subjects, who were working at the approximate practise limit. Carothers's data are from initial trials. Nevertheless the magnitudes of the variations about these central tendencies do not differ much in the two cases. In the

case of 100 adults, from the Carothers data, the semi-interquartile range for Tapping was 27.6, while the average for our six subjects is 28.0. The measure of deviation for adults in Coördination was 7.5, which is precisely the average in the case of our six individuals. In Color Naming, on the other hand, Carothers's semi-interquartile range was 5.3, while the average for our subjects is only 2.1. So far as the data are available, individuals seem to vary from their own average in quite the same way that they differ from the central tendency of their group. The degree to which this is the case may vary with the nature of the process, but we do not have material adequate for a further study of this point.

Intra-individual Self-correlation of Processes

In making these correlations of the data we inquire concerning the degree of *stability* which the act manifests within a given individual—its tendency to be at a given level and to remain there for a period of time, such as an hour or so. Are the factors that modify efficiency in the process very transient, influencing only single trials, or do they hang over, influencing trials at later periods during the hour? If the former, we may think of them as incidental to the single trial, and perhaps arising out of the circumstances of that moment. If the latter, we may think of them as inhering in the general condition of the individual for the duration in question.

By way of examples, we may think of *body temperature* as illustrating the latter situation. A feverish condition does not suddenly arise and as suddenly disappear—instead it persists for a considerable duration, thus constituting a general feature of the individual.

At the other extreme we may think of such a feature as *direction of vision*, which varies from moment to moment, according to the events of the moment, thus being episodic rather than constitutional.

Between these two extremes we may suggest such features as mood, fatigue, hunger, and the like. These are not as stable as fever nor as transient as visual regard, but have an intermediate degree of stability, varying over relatively short intervals according to the events of the occasion.

One of these intermediate features we have measured, viz. *pulse rate*. Assuming conditions of relatively constant degree of movement and excitement, such as characterise a forenoon devoted to these experiments, we may suppose that pulse rate will be a fairly stable feature, but not a perfectly stable one. Our figures show a correlation of .86 to represent the degree of stability shown by pulse rate under these conditions. Other processes may be compared with this as a point of reference.

TABLE II

INTRA-INDIVIDUAL SELF-CORRELATION OF PROCESSES

Subj.	Tapping	Coördination	Steadiness	Substitution	Color Naming	Pulse Rate	Individual Median Excluding Pulse
1.....	.57	.64	− .21	.33	− .17	.89	.33
2.....	.05	.64	.41	.16	.27	.87	.27
3.....	.50	.60	.17	.63	.24	.85	.50
4.....	.57	.07	.58	.53	.18	.70	.53
5.....	.00	.71	.27	.27	− .20	.90	.27
6.....	.77	.39	.41	.34	.41	.72	.41
Median..	.54	.62	.34	.33	.21	.86	.37

TABLE III

AMOUNTS OF INDIVIDUAL GAIN (PER CENT. OF INITIAL RECORD) DISTRIBUTED OVER THE 42 TRIALS (TOTAL GIVEN)

Subj.	Tapping	Coördination	Steadiness	Substitution	Color Naming	Pulse Rate	Excluding Pulse Medians
1.....	− 11%	− 6%	33%	8%	3%	− 2.3%	3%
2.....	− 3%	15%	24%	− 1%	− 12%	− 4.4%	− 1%
3.....	6%	5%	19%	8%	0%	4.1%	6%
4.....	4%	4%	79%	20%	4%	3.0%	4%
5.....	10%	22%	52%	19%	− 7%	4.6%	19%
6.....	34%	6%	28%	6%	11%	0.9%	11%
Median..	5%	5%	30%	8%	1%	1.9%	5%

None of the processes is so consistent, from individual to individual, as is Pulse Rate, which ranges only from .70 to .90 in the six individuals. The other processes fall into three groups. Next to Pulse Rate, in stability, come Tapping and Coördination, with median stability coefficients of .54 and .62

respectively. Except for two individuals in Tapping and one in Coördination, the figures are also quite uniform. Next in stability come Steadiness and Substitution, with coefficients of .34 and .33. Finally, the least stable of all is Color Naming, with median coefficient of only .21.

These results are not to be confused with 'reliability coefficients,' such as are secured from repeating a test on a group of individuals. Such 'reliability coefficients' disclose the accuracy with which a given performance places an individual in the group. If individual scores range over a considerable stretch of the scale, such reliability coefficients may be quite high. But in this case we learn only how reliably a single performance discloses the individual's position within his own range of variable scores. In such a test as Color Naming the individual's variation from his own average is very slight, and a difference of a fraction of a second is often all that differentiates two scores.

In ordinary cases then, and unless special factors are introduced which materially change the performance at given times, this amounts to a restriction of the range, and thus tends to lower coefficients of correlation. This is especially the case insofar as the individual's variations from his own average are smaller than the variations of the members of a group of individuals from the group average. How these two types of variation compare in different processes we may inquire in a moment, basing our conclusion on such data as those here used for single individuals.

Naturally, if any general or uniform influence, such as improvement through repetition, or such as the course of fatigue, affects the data, these factors will tend to produce positive self-correlations in the records. In the case of practise, for example, the poorer records in both series would on the whole tend to come earlier and the better records later. In the case of fatigue the reverse would tend to happen, in so far at least as continued work produces reduced scores.

But we have sought to eliminate such general tendencies so far as possible. By using only forenoon records, the results of continued work are practically eliminated. By using only

records secured when practise improvement had practically ceased, we tend to eliminate this influence. But the elimination is not complete, as the table of practise gains shows.

In spite of all these precautions, that is to say, there is still a slight gain in some of the processes, resulting from practise. Using the medians of the six subjects, this gain amounts to about 5 per cent. of the initial record. Since this amount of gain, distributed over 42 trials, is very small, amounting to only about one eighth of one per cent. (.0012) per trial, it may be supposed that the irregular variations from trial to trial will quite overshadow this slight tendency. This is clearly the case with steadiness, which has low stability in spite of considerable practise gain.

The table shows the gains for each individual in each process, secured by comparing the median scores of the first eleven and the last eleven trials. As a matter of fact the individuals who have the highest self-correlation coefficients do tend on the whole to be those whose practise gain, in the given process, was greatest. On the other hand, some individuals with no definite practise gains show high stability coefficients, and some with considerable gains show low coefficients. It seems impossible completely to eliminate the influence of these slight gains from the coefficients, although this condition is fairly approximated.

Intra-individual Inter-test Correlations

The intra-individual inter-test correlations disclose the degree to which momentary variation in one process accompanies a corresponding deviation in other acts. Thus instead of inquiring into the stability of the Tapping performance, we inquire whether a superior moment for Tapping is also characterized by superior performance in other tests as well. By superior, in this connection, we mean merely with reference to the individual's own standard of achievement, without reference to his relation to the performance of other individuals.

We are thus inquiring into the correlation of traits *within* an individual. Are the various performances quite unrelated, each depending for its success chiefly on the accidents of the

particular act? Or does one's performance show general fluctuations, showing in any or all acts attempted in a given period? Thus, the momentary illumination of the room, or an accidental stumble, might interfere with performance in Steadiness at a given period, but have no influence on Tapping. On the other hand, such general influences as inattentiveness, rage, or a dose of alcohol would represent more widespread factors which might conceivably show their effects in whatever act the individual might undertake at the moment. Is the efficiency of the moment specific to the particular act, then, or is it more systemic in character?

The table shows the medians of the six subjects, for each of the processes in correlation with each of the others. In parenthesis is given, for each process also, the figure for its stability or self-correlation, as given in preceding tables. The figures for Pulse Rate are given in this table, along with the 'tests' as the term is more usually used; since there seems to be no essential difference between Pulse Rate and the other acts, so far as inter-correlations are concerned.

TABLE IV

INTRA-INDIVIDUAL INTER-TEST CORRELATIONS

(*Medians of Six Individuals*)
(Figure in parenthesis gives Median Self-correlation of each test)

	Tapping	Coördination	Steadiness	Substitution	Color Naming	Pulse Rate	Median Excluding Self Corr.
Tapping	(.54)	.36	.20	.17	.18	− .11	.18
Coördination	.36	(.62)	.16	.33	− .05	− .02	.16
Steadiness	.20	.16	(.34)	.12	.15	− .12	.15
Substitution	.17	.33	.12	(.33)	.21	.24	.21
Color naming	.18	− .05	.15	.21	(.21)	.12	.15
Pulse rate	−.11	− .02	− .12	.24	.12	(.86)	− .02

The correlations, as shown by these median figures, are very low, and tend only slightly to be predominately positive. The median of all the correlations is about .15. In the graph is shown the distribution of all the ninety individual correlations used in deriving this table of medians, the six tests giving fifteen coefficients for each of the six subjects. The

mode of the distribution falls between .10 and .20, while 32 per cent. of the coefficients fall below 0.

As we have indicated at another point, there was a slight amount of improvement in most of the processes here studied, and perhaps this amount, slight as it was, gave sufficient general trend to the scores to account for an average correlation of .15, and to throw the mode of the distribution somewhat above the zero point.

Allowing for such effect as the practise gain may have had, we must conclude that the data afford no reason for assuming that there is any such thing as a systemic efficiency that determines the minor variations in these performances (no reference is made to major factors such as fatigue, intoxication, interest, sleepiness, and the like, which factors must be separately studied in situations in which they are manifestly present.) There is no indication that efficiency in one process indicates degree of efficiency in another process during the same period of time. Excellent performance in Color Naming, in a given half hour, may accompany inferior performance in Tapping. The determinants of these acts, in the degree of automatisation which they have reached by the 40th trial, seem to be momentary and episodic factors, transient or inhering in the course of the act itself, or in the immediate environment, rather than in any general systemic feature of the organism.

It is noticeable that the stability coefficients are considerably higher than these inter-test coefficients, although based on a smaller number of cases (21 pairs instead of 42 pairs of records). Thus Tapping and Coördination correlate about .60 with themselves, but only .36 with one another, and not over .18 with the other processes. Pulse Rate correlates .86 with itself but averages just no correlation with the other processes, the separate figures ranging only from − .12 to .24, with the median at − .02.

That is to say, the indication is that Tapping, for example, is a stable function, and that tapping ability at one moment reveals the level of ability in that general function over a considerable period of time (in this an interval of one hour). And

so with other processes whose stability coefficients is high (especially Coördination). In every case the stability coefficient is higher than any of the correlations with other processes.

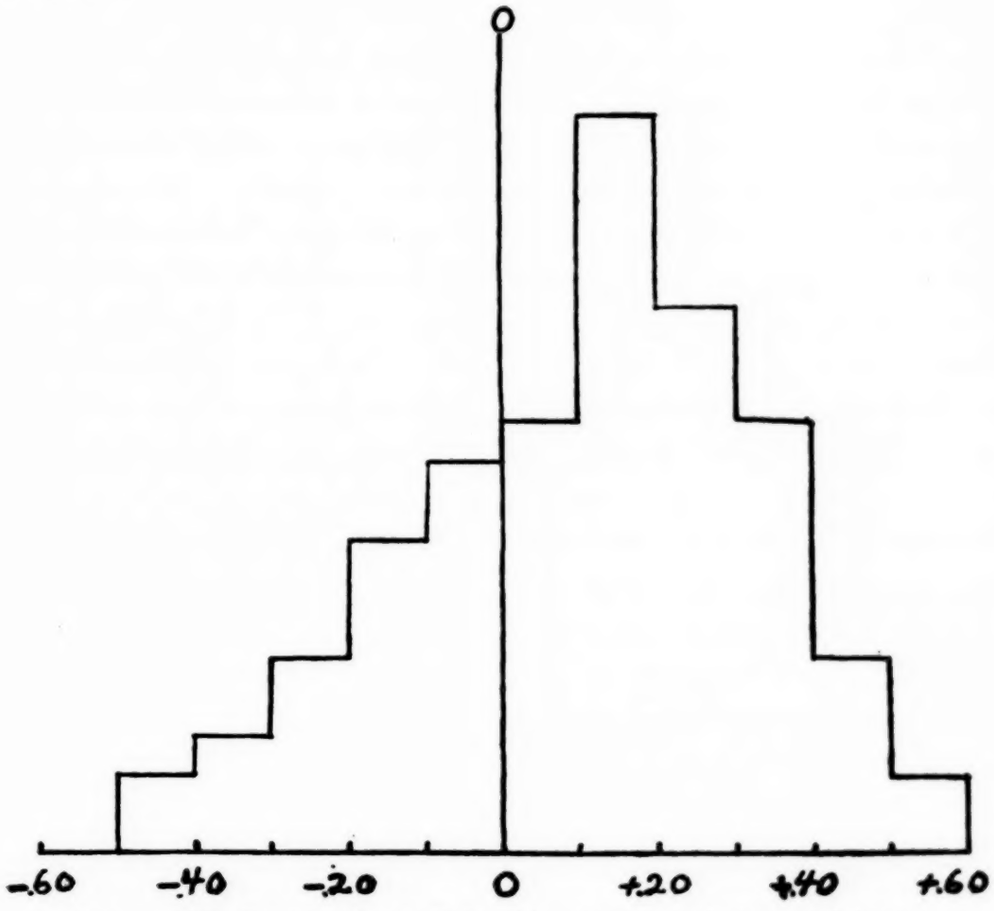

FIG. 1. Distribution of 90 individual inter-test correlation coefficients.

If Tapping and Coördination should correlate as closely with one another as with themselves, the indication might be supposed to be that some more general factor, such as 'motor ability' was involved. As it happens, however, although the inter-correlation of Tapping and Coördination is the highest of the table, it is small (.36) as compared with the stability coefficients of the two processes themselves (.54 and .62).

In the case of Color Naming the stability coefficient is only slightly larger than the inter-correlations, and all are so small as to be unreliable. Now although a high stability index would seem to argue for a more or less unitary proficiency or function, a low stability coefficient need not argue to the

contrary. It might instead mean only that the local and episodic factors, in this process, produce greater variations than does the variation of the systemic factor or function.[1]

Individual Differences

These intra-individual correlations were originally undertaken in the hope that by this means some index might be secured which would suggest the 'degree of integration' or the 'dissociative tendency' of different individuals. The idea suggested was that perhaps a wellknit individual, mentally, would show a degree of intra-individual correlation in his various performances different from that shown by a less well organised person.

The direction of the difference, if such was to be found, was not easy to predict in advance. On the one hand it might be expected that a well integrated individual would be one whose system is so closely associated in its various parts that an interference at one point would show itself in a widespread fashion, as a general disturbance, or departure from standard. Such an individual would, on this count, be expected to show high positive inter-correlations of acts.

On the other hand, it might be supposed that in the case of the well integrated individual, disturbance at one point in the system would tend to be adequately compensated by adjustments at other points, so that no systemic inadequacy would be revealed. Instead the variations in different performances would reflect merely the local and episodic and immediately environmental influences, whether of facilitation or of interference, and inter-correlations would in such a case tend to be low, and neither clearly positive nor negative. This leaves still a hypothetical individual, who might show large negative inter-correlations, showing marked independence or inverse relationships.

With simply the general question in mind, then, and with no formulated hypothesis, the data were examined to discover first of all whether in the subjects available any characteristic individual differences were to be found.

In another connection these six subjects have been studied

with respect to their susceptibility to the effects of alcohol. They have been shown to divide into three pairs, a very susceptible, a moderately susceptible, and a very resistant pair. In the following table the subjects are arranged on the basis of this grouping, and their median coefficients are also given from the data here being considered.

TABLE V

Subjects	Median Stability Coefficients (Excluding Pulse)	Median Inter-test Coefficients (Including Pulse)
Very Susceptible		
A	.27	.22
B	.27	.10
Moderately Susceptible		
C	.33	−.12
D	.50	.17
Very Resistant		
E	.53	.16
F	.41	.04

The inter-test correlations are all so low that no reliable individual differences are revealed. In the case of the stability coefficients however there is a suggestion that may be worth following up with a larger number of subjects. The susceptible subjects are those with the lowest indices of stability, the averages for the three pairs, in order of decreasing susceptibility, being .27, 41, and .47. The average of the most susceptible three is .29, of the resistant three is .48.

In the previous study we have shown that drug resistance goes with higher ability in test performance, and also with greater capacity for gain through practise. The present finding indicates that along with these three desirable traits goes also a high stability index. There is then at least a suggestion that variability from one's own average, under ordinary conditions of work, may afford a useful index of integration or of general systemic effectiveness.

From the point of view of the mechanics of mental work, some interest attaches to the inter-test correlations within an individual, even though those shown here are small. The consistency of direction of even small correlation coefficients is often suggestive.

Thus Pulse Rate correlates negatively with the three motor or manual acts but positively with the more abstract, symbolic or verbal processes. Of the six correlations of Pulse Rate with Tapping, only one is positive, the remaining being either negative or zero. With Coördination, three coefficients are negative, one practically zero, and but two positive. With Steadiness five coefficients are negative.

On the other hand, of the six correlations of Pulse Rate with Substitution, five are definitely positive and the sixth is only $-.05$. In the case of Color Naming there is only one negative coefficient.

The best single index is Substitution, which correlates positively with all the other processes, including Pulse Rate. The median of the thirty correlations with Substitution (five processes and six individuals) however is but .21.

Comparison of Group and Inter-individual Correlations

It is of some interest to compare the correlation of performance within the individual with the similar correlation found between the performances of a group of individuals in different functions. We are enabled to make certain comparisons in the present instance by utilising the data accumulated by Carothers, who used some of the tests we have here employed, on college girls. She determined the 'reliability coefficients,' by giving the same tests twice to a group of 45 students, comparable in number to our group of 42 pairs of trials. She also computed inter-test correlations on a group of 100 individuals. In the following we give, for the four tests that may be compared, our own figures and, in parenthesis, the figures from the data of Carothers.

Table VI

Index of Stability Compared with Index of Reliability

	Stability	Reliability
Tapping	.54	(.77)
Coördination	.62	(.66)
Color Naming	.21	(.88)
Substitution	.33	(.70)

The indices of stability are lower than those of reliability,

in part perhaps because in the latter case unpractised individuals were used. In our own case the attainment of the practise limit or thereabouts in each case definitely restricts the range of variability, and decidedly limits the causes of variability, thus in general tending to lower the correlations.

TABLE VII

INTRA-INDIVIDUAL AND INTER-INDIVIDUAL TEST CORRELATIONS

	Coördination	Color Naming	Substitution
Tapping	.36 (.48)	.18 (.33)	.17 (.21)
Coördination		− .05 (.10)	.33 (.25)
Color Naming			.21 (.32)

The inter-individual correlations, from Carothers, are given in parentheses, alongside our own intra-individual correlations. The differences are after all not striking. In both cases Tapping and Coördination give the highest correlation. Although in all but one case (Coördination and Substitution) the intra-individual coefficients are smaller, the differences are far from suggesting that closer relationships are shown in the one case than in the other. Our own figures are based only on 42 pairs, while those of Carothers are based on the study of 100 pairs of cases, and are more reliable.

On the whole the comparison suggests that the various processes, in so far as they are reliably measured in these tests, are relatively independent, and that their degree of coherence is scarcely greater as between individuals than as within the individual from moment to moment.

COEFFICIENTS OF VARIABILITY

Since, with these six subjects at least, the coefficients of stability seem to bear some definite relation to susceptibility to the drug employed, it was naturally suggested that a direct measure of the variability of an individual about his own average performance might show a similar relation. Using, for each individual, the median of the 42 trials as the measure of central tendency, the deviations of the separate trials from this median were computed, and their average in each process,

taken as the measure of the individual's variability. Since the median performances differed somewhat also, these measures were divided, in each case, by the central tendency from which they were computed, this giving the Pearson coefficient of variability, for each individual in each process. These coefficients ranged from 3 per cent. to 15 per cent. except in Steadiness, in which the per cent. variabilities were much larger.

In order to make the results for all processes as comparable as possible, the individuals have been assigned their relative ranks in these variability coefficients, in each process separately (excluding the Pulse Rate, in which no consistent differences are shown). In the following table the subjects are arranged according to degree of alcohol susceptibility, the most susceptible coming first, and these ranks, with their summary, are given. In a final column the previously given Stability Coefficients are repeated.

Table VIII

Coefficients of Variability

(Ranked in Order of their Magnitude)

Subj.	Tapping	Coördination	Steadiness	Substitution	Color Naming	Median Rank	Average Rank	Stability Index
A.....	2	1	3	1	1	1.0	1.6	.27
B.....	3	2	4	3	4	2.5	3.2	.27
C.....	4	3	2	2	6	2.5	3.4	.33
D.....	5	4	6	4	3	4.0	4.4	.50
E.....	6	6	1	5	5	5.5	4.6	.53
F.....	1	5	5	6	2	5.5	3.8	.41

The ranks for Variability correspond very closely to the ranks for Susceptibility, as is also the case with the rank for Stability. If we divide the group into a susceptible trio and a resistant trio, the average values for these two sub-groups are as follows.

Table IX

Sub-Group	Variability Index Average of Medians	Stability Index Average of Coefficients
Susceptible Trio Subjects *A, B, C*.....	2.0	.29
Resistant Trio Subjects *D, E, F*.....	5.0	.48

Inspection of the figures for practise gain shows that these results bear no consistent relation to the amount of improvement during this part of the experiment (the gain at best being very small in comparison with the number of repetitions of the tasks). It seems clear that both the Variability Coefficients and the Stability Indices bear a significant relation to Susceptibility—that those who are most disturbed by small and incidental influences in the ordinary course of their work are also those who are most disturbed by the larger and more deliberate influence represented by the experimental drug doses. It seems fair to say that in a sense the drug influence only exhibits on a larger scale the instability already inherent in the individual's 'normal' work.

Summary

1. In an array of performances by six individuals, after preliminary practise has practically eliminated gain from repetition, notable variations in score are nevertheless found, which are symmetrically distributed about their central tendency.

2. Using such records, Stability Indices, Coefficients of Variability, and Intra-individual Correlations have been computed for six well-known processes.

3. Intra-individual Correlations, between different types of process, approach zero (except as the slight practise gain still present shifts the mode slightly above the zero point). Normal deviations in different types of work thus seem to depend on local and episodic rather than on systemic determinants, although the actual correlations (within an individual) are not much smaller than those ordinarily found between such performances in a group of individuals.

4. Stability Indices are higher than the intra-individual correlations for different processes, but lower than 'reliability' coefficients secured from a group of individuals. Stability Indices are inversely related to susceptibility to alcohol.

5. Coefficients of Variability are closely related to Stability Indices, and vary inversely with drug resistance (alcohol).

6. Superior average performance, high Stability Indices, low Variability Coefficients, Capacity for Gain through repetition, and high drug Resistance, are positively associated, as are their various corresponding degrees.

7. These interesting indications suggest the desirability of a more elaborate investigation of such relationships, on a larger array and range of individuals.

THE RESISTANT BEHAVIOR OF INFANTS AND CHILDREN. II

BY DAVID M. LEVY AND SIMON H. TULCHIN

Institute for Juvenile Research, Chicago.
State of Illinois, Department of Public Welfare.

Further work on the study of 'resistance of infants and children during mental tests' [1] consisted in making detailed records of the behavior manifested. Notes were recorded immediately while the children were being tested, from the moment of entrance into the testing room to the time of exit. The items grouped themselves into convenient classifications, designated in Table I. The resistance-patterns of one hundred and ten children, six to fifty-four months of age, were tabulated in this way. They represent one hundred and ten out of a total of two hundred and forty-two cases examined in one town. In the following table the number, studied in such detail, are arranged according to sex in six-month age groups.

Age in Months	Male	Female
6–11	13	9
12–17	11	10
18–23	8	5
24–29	4	10
30–35	7	3
36–41	4	6
42–47	9	4
48–53	1	6
Total	57	53

Table I., the key table, contains the resistance pattern of every child in the group studied. These resistances are classified into eight groups, according to a characteristic and increasingly complex mode of response. For each group the cases are distributed by age in two month periods and by sex. It should be noted that crying was recorded as an item of

[1] 'The Resistance of Infants and Children During Mental Tests,' Levy, D.M., and Tulchin, S.H., J. Exp. Psych., 6, 304, Aug. 1923.

TABLE I

DISTRIBUTION OF RESISTANCES BY AGE AND SEX

Age in Months		6 7	8 9	10 11	12 13	14 15	16 17	18 19	20 21	22 23	24 25	26 27	28 29	30 31	32 33	34 35	36 37	38 39	40 41	42 43	44 45	46 47	48 49	50 51	52 53	54	Total
Number males		6	3	4	3	3	5	4	2	2	2	1	1	2	5	0	1	2	1	2	3	4	0	0	0	1	57
Number females		5	0	4	3	2	5	4	1	0	1	4	5	1	2	0	2	2	2	4	0	0	2	0	4	0	53
1. Crying but not struggling or clinging	M.	5	3	4	0	1	2	2	1	0	1	0	1	1	1	...	...	...	...	...	...	...	...	...	...	...	22
	F.	4	0	3	2	2	1	2	0	0	0	3	5	1	1	...	...	1	1	2	...	...	1	...	1	...	31
2. Clinging to mother—																											
(*a*) And crying	M.	1	0	0	1	1	2	1	1	0	0	0	0	...	1	...	...	...	...	...	...	2	...	...	...	...	10
	F.	0	0	1	0	0	0	0	0	0	0	0	0	...	...	...	...	...	...	...	...	...	...	...	1	...	2
(*b*) Not crying	M.	...	...	...	1	...	...	1	...	...	...	...	...	...	2	...	...	...	...	...	2	1	...	...	...	...	7
	F.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1
(*c*) Pressing closely to mother	M.	...	...	...	1	...	...	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
	F.	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1
3. Pushing away toys—																											
(*a*) And crying	M.	...	...	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
	F.	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
(*b*) Not crying	M.	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	3
	F.	...	...	...	...	...	1	1	...	...	...	1	2	...	1	...	...	...	...	...	...	...	...	...	...	...	2
4. Hitting—																											
(*a*) Slapping movements without actually slapping	M.	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
	F.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1
(*b*) Slapping examiner	M.	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1
	F.	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
(*c*) Pushing examiner away	M.	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...	2
	F.	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	1	...	3
5. (*a*) Screaming and struggling	M.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	2	...	...	...	...	...	3
	F.	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
(*b*) Screaming, not struggling	M.	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
	F.	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
(*c*) Struggling, not crying or screaming	M.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0
	F.	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1

TABLE I.—*Continued.*

Age in Months		6 7	8 9	10 11	12 13	14 15	16 17	18 19	20 21	22 23	24 25	26 27	28 29	30 31	32 33	34 35	36 37	38 39	40 41	42 43	44 45	46 47	48 49	50 51	52 53	54	Total
6. (*a*) Several withdrawal movements with or without taking object	M.			1																							1
	F.			1			1						1														3
(*b*) Walking back to mother, 'changing mind'	M.																										0
	F.																			1							1
(*c*) Turning head and burrowing	M.														1												1
	F.																								1		1
(*d*) Turning head away to mother	M.				1														1	1		2					5
	F.				1		2						1							1							5
(*e*) Head downward	M.																										0
	F.																	1	1								2
(*f*) Covering face with hands	M.							1																			1
	F.						1				1		1		1					1							5
(*g*) Looking away	M.									1				1													2
	F.				1							1					1	1	1				1		1		7
7. (*a*) No response—Looking at object but not taking it	M.	1	1					1			2			1								1				1	8
	F.	1		2	1	1												1		2							8
(*b*) Just looking at examiner	M.											1							1	1							3
	F.								1									1									2
(*c*) Limp hands	M.																										0
	F.																								2		2
8. (*a*) Shaking head	M.						1						1	1			1	1			2						7
	F.																1			2							3
(*b*) Using words	M.													1	4			1		1	2						9
	F.						1					2	2		2			1	3				1				12

resistance regardless of its interference with testing. All other items in resistance such as struggling, kicking, pushing and so on were so considered. In the previous investigation resistance was recorded only when it interfered with the completion of one or more tests of any series.

In Table I.-*A* the words used by the children are listed and classified by age and sex. The sexes are fairly well distributed. It is noted that the five youngest to use words are all females.

TABLE I-*A*

Words Used		Age in Months									
		16	26 27	28 29	30 31	32 33	38 39	40 41	42 43	44 47	48 53
No! No!	M.	...	...	...	1	3	...	...	...	1	...
	F.	1	2	1	...	1	...	1	...	...	...
I don't want it	M.	...	...	...	...	1	...	...	...	...	...
	F.	...	...	...	...	1	...	...	...	...	...
I can't	M.	...	...	...	...	...	1	...	...	1	...
	F.	...	...	...	...	...	1	1	...	...	1
I won't	M.	...	...	...	...	...	...	...	1	...	...
	F.	...	...	...	...	...	...	...	...	...	...
I'm about to cry	M.	...	...	...	...	...	...	...	...	...	...
	F.	...	...	...	...	...	...	1	...	...	...
I want to go down	M.	...	...	...	...	...	...	...	...	...	...
	F.	...	...	1	...	...	...	...	...	...	...

In Table II. are recorded the number, age and sex of children manifesting resistant behavior when they were entering the examining room. This was chiefly crying and screaming, crying and struggling, or crying with some other manifestation. It occurred most frequently in the females at seventeen months, and in the males at twenty-eight to thirty-six months. It confirms observations recorded in the previous paper showing the highest peak of resistance for females in the eighteen month group and for males in the thirty month group. Under seventeen months only two instances of crying at entry occurred. Where crying occurred with struggling and screaming, not one case was recovered for further testing (average time of test, ten minutes).

TABLE II

RESISTANCE AT ENTRY

Age in Months		6	17	18	30	32	38	46
1. Enters crying only	M.	1	...	...	...	1	...	...
	F.	...	...	1	...	...	...	...
2. Clinging without crying	M.	...	...	...	...	1	...	1
	F.	...	...	...	...	...	...	...
3. Clinging with crying	M.	1	...	...	...	...	...	2
	F.	...	...	...	...	...	...	...
4. Crying with screaming	M.	...	1	...	...	...	...	...
	F.	...	1	1	...	...	...	...
5. Crying with struggling	M.	...	...	...	...	...	...	...
	F.	...	1	...	...	...	...	...
6. Crying with stamping feet	M.	...	...	...	...	...	1	...
	F.	...	...	...	...	...	...	...
7. Crying with hands over face	M.	...	...	...	...	...	...	...
	F.	...	1	...	...	1	...	...
8. Crying with shaking head	M.	...	...	...	1	...	...	...
	F.	...	...	...	...	...	...	...
9. Crying with saying No! No!	M.	...	...	...	1	...	...	...
	F.	...	...	...	...	...	...	...

TABLE III

CHRONOLOGIC APPEARANCE OF RESISTANCE PATTERNS

Noted at 6–7 months ..... Crying but not struggling or clinging.
Crying and clinging.
No response, looking at object but not taking it.

First noted at:

10–11 months ..... Several arm withdrawal movements, whether taking object or not.

12–13 months ..... Clinging to mother, but not crying.
Crying and pushing toys away.
Pressing closely to mother.
Turning head away to mother.

14–15 months ..... Screaming but not struggling.

16–17 months ..... Pushing away toys but not crying.
Screaming and struggling.
Slapping movements but not slapping.
Shaking head.
Using words.

20–21 months ..... Just looking at examiner.

26–27 months ..... Struggling but not crying or screaming.
Slapping examiner.
Pushing examiner.

32–33 months ..... Turning head and "Burrowing" into mother.

40–41 months ..... Turns head downward.

42–43 months ..... Walking back to Mother (Changing mind).

52–53 months ..... Limp hands.

Table III. is a 'resistance chronology' for the group studied. Further work will make possible an accurate table of resistance-patterns arranged in order of complexity based on the age of first appearance. If the items resembling each other are grouped together, and in the correct order of appearance, we have the following classification.

Table IV

Resistance Patterns Arranged According to Similarity of Reactions

Within each group the arrangement is chronological, and the age of first appearance indicated.

I. Crying but not struggling or clinging. (6 months.)

II. Clinging to mother.
- (*a*) Crying and clinging. (6 months.)
- (*b*) Clinging, not crying. (12 months.)
- (*c*) Pressing closely to mother. (12 months.)

III.
- (*a*) Crying and pushing toys away. (12 months.)
- (*b*) Pushing toys, not crying. (16 months.)
- (*c*) Slapping movements at examiner. (16 months.)
- (*d*) Slapping or pushing examiner. (26 months.)
- (*e*) Shakes head. (16–17 months.)
- (*f*) Says "No! No!" etc. (16–17 months.)

IV.
- (*a*) Screaming not struggling. (14–15 months.)
- (*b*) Screaming and struggling. (16–17 months.)
- (*c*) Struggling not screaming. (26 months.)

V.
- (*a*) Several arm withdrawal movements. (10 months.)
- (*b*) Turns head away to mother. (12 months.)
- (*c*) Covers face with hands. (16 months.)
- (*d*) Turns head and "burrows" into mother. (32 months.)
- (*e*) Head downward. (40 months.)
- (*f*) Walks back to mother after starting for an object (changes mind). (42 months.)

VI.
- (*a*) No response, just looks at object. (6 months.)
- (*b*) Looks at examiner. (20 months.)
- (*c*) Hands limp when object is put into hand. (52 months.)

It must be remembered that this paper is simply a tabulation of one hundred and ninety-five resistive performances on the part of one hundred and ten infants and children, itemized in twenty-five columns designating progressive age periods of two months. The divisions are so many, that in each the number of reactions studied is too small for an accurate chro-

nology of resistance patterns. The order designated in Table IV. will no doubt be revised as data accumulate.

The purpose of using two month intervals groupings, probably too minute for the relatively small mass of data, is to find, if possible, crucial age periods within which certain patterns first appear or accumulate. Wider contrasts in six and twelve month groupings follow in Tables V. and VI. The same tables for the sexes separately in twelve and six month intervals follow in Tables VII., VIII., and IX.

A detailed study of the findings follow Table IX.

TABLE V

NUMBER OF CASES IN EACH RESISTANCE GROUP BY AGE IN SIX MONTHS INTERVALS

Total Number of Cases	22	21	13	14	10	10	13	7	
Age Groups	6–11 Mos.	12–17 Mos.	18–23 Mos.	24–29 Mos.	30–35 Mos.	36–41 Mos.	42–47 Mos.	48+ Mos.	Total
1. Crying	19	8	6	10	4	2	2	2	53
2. Clinging (2 *a*, *b*, *c*,)	2	6	5	2	3	1	5	1	25
3. Pushing Toys (3 *a*, *b*)	0	5	1	3	2	0	0	0	11
4. Hitting examiner	0	1	0	3	2	2	0	1	9
5. Screaming and struggling (5, *a*, *b*, *c*)	0	3	2	1	0	1	2	0	9
6. Hiding (6, *a*, *b*, *c*, *d*, *e*, *f*, *g*)	2	7	2	5	3	6	6	3	34
7. Passive (7, *a*, *b*, *c*)	5	2	2	3	1	3	4	3	23
8. Talking	0	2	0	5	8	8	7	1	31

TABLE VI

NUMBER OF CASES IN EACH RESISTANCE GROUP BY AGE IN TWELVE MONTH INTERVALS

Total Number of Cases	22	34	24	23	7	
Age Groups in Months	6–11	12–23	24–35	36–47	48+	Total
1. Crying	19	14	14	4	2	53
2. Clinging	2	11	5	6	1	25
3. Pushing toys	0	6	5	0	0	11
4. Hitting examiner	0	1	5	2	1	9
5. Screaming and struggling	0	5	1	3	0	9
6. Hiding	2	9	8	12	3	34
7. Passive	5	4	4	7	3	23
8. Talking	0	2	13	15	1	31

TABLE VII

NUMBER OF CASES IN EACH RESISTANCE GROUP BY SEX AND AGE IN ONE YEAR INTERVALS

	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Total Number of Resistances	
Total Number of Cases	13	9	19	15	11	13	13	10	1	6		
Age Groups	6–11 Mos.		12–23 Mos.		24–35 Mos.		36–47 Mos.		48+ Mos.			
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1. Crying	12	7	6	8	4	10	0	4	0	2	22	31
2. Clinging	1	1	11	0	4	1	5	1	0	1	21	4
3. Pushing toys	0	0	3	3	1	4	0	0	0	0	4	7
4. Hitting examiner	0	0	1	0	2	3	1	1	0	1	4	5
5. Screaming and struggling	0	0	2	3	0	1	3	0	0	0	5	4
6. Hiding	1	1	3	6	2	6	4	8	0	3	10	24
7. Passive	2	3	1	3	4	0	3	4	1	2	11	12
8. Talking	0	0	1	1	7	6	8	7	0	1	16	15

TABLE VIII

NUMBER OF CASES IN EACH RESISTANCE GROUP BY AGE IN SIX MONTH INTERVALS

Males

Total Number of Cases	13	11	8	4	7	4	9	1	Total
Age Groups	6–11 Mos.	12–17 Mos.	18–23 Mos.	24–29 Mos.	30–35 Mos.	36–41 Mos.	42–47 Mos.	48+ Mos.	
1. Crying	12	3	3	2	2	0	0	0	22
2. Clinging	1	6	5	1	3	0	5	0	21
3. Pushing toys	0	3	0	0	1	0	0	0	4
4. Hitting examiner	0	1	0	0	2	1	0	0	4
5. Screaming	0	2	0	0	0	1	2	0	5
6. Hiding	1	1	2	0	2	1	3	0	10
7. Passive	2	0	1	3	1	1	2	1	11
8. Talking	0	1	0	1	6	3	5	0	16

Crying.—As previously noted this is the chief type of resistance, if it can be called such, manifested by babies under six months of age. The group, three to five months, was not included. For this series crying was the most frequent reaction noted. As a sole manifestation it occurred 53, and combined with other modes of conduct, 26, altogether 79 out of the 195 items enumerated. It gradually lowered in frequency (Table V.), though it appeared in each age group

studied. From the 30th to the 54th month it is in the fourth place in the list of resistance-frequencies. Of the 28 items enumerated in the 6–11 month group, 19 are 'crying only.' Of the 26 items in the 42–47 month group, but two are 'crying only.' In a group of unselected 54 to 60 month children, in the situation studied, it would be rare. After the twelfth month it occurred more frequently in females than in males (Tables VII., VIII. and IX.). There was a consistently sharp contrast after the third year when it occurred as a sole manifestation in 6 out of 16 females, and not once in 15 males.

TABLE IX

NUMBER OF CASES IN EACH RESISTANCE GROUP BY AGE IN SIX MONTH INTERVALS

Females

Total Number of Cases	9	10	5	10	3	6	4	6	
Age Groups	6–11 Mos.	12–17 Mos.	18–23 Mos.	24–29 Mos.	30–35 Mos.	36–41 Mos.	42–47 Mos.	48+ Mos.	Total
1. Crying	7	5	3	8	2	2	2	2	31
2. Clinging	1	0	0	1	0	1	0	1	4
3. Pushing toys	0	2	1	3	1	0	0	0	7
4. Hitting examiner	0	0	0	3	0	1	0	1	5
5. Screaming	0	1	2	1	0	0	0	0	4
6. Hiding	1	6	0	5	1	5	3	3	24
7. Passive	3	2	1	0	0	2	2	2	12
8. Talking	0	1	0	4	2	5	2	1	15

Combined with some other act, as 'clinging' or 'pushing toys away,' crying occurred with about equal frequency in both sexes (Males 35, Females 34). With the same combinations, however, the contrast was strong after the 36th month (Males, 2 out of 14, Females, 8 out of 16).

In this paper crying is not further differentiated as to type, except to distinguish it from screaming. It is accepted as an innate response. Its gradual lowering in frequency with increasing age will, in the main, be considered an 'innate' adaptation, secondarily modified by parental instruction, *i.e.* as the child grows older crying is less likely to be tolerated, the child is shamed, etc. Most likely, such instruction, as usual, follows the general observation of the natural—the gradual letting up

of crying as a resistive response. That crying is more likely to be tolerated in girls than in boys may follow the same rule. This contrast of the sexes is most likely not artificially acquired, since the differences appear from the 12–17 month group and on, at an age preceding the time when the sexes might be treated differently.

The question, "What is resistance and what is being resisted?" is pertinent to this enquiry, especially in reference to crying. In the first report 'resistance' was designated as any behavior that interfered with intelligence testing, the number of tests taken being the measure, roughly, of the 'amount' of resistance. When it was found that children so frequently resist being tested, the intelligence-test was utilized experimentally as a convenient method of arousing and so studying resistance-patterns. But the intelligence test in a county fair is not a simple stimulus, nor is the 'resistant' reaction. The cry of the child, for example, may have been a response to the general noise and confusion, to experiences preceding the test, to the face or sound of the examiner's voice. It may have cried because it was afraid, or angry, or confused rather than that it didn't want to be tested. Whatever the interpretations may be we have a series of responses occurring during a situation so controlled as to be comparable for a large group of children. These responses measured against the same criterion (number of tests taken) gave uniformly similar findings. It was concluded that they were primarily innate behavior patterns. In this paper we are merely studying these patterns in detail. In general it may be inferred that when they occur they are responses to a more or less unpleasureable situation (whether to the tests directly or to any other phase of the experience). On this basis we may infer that infants cry less as they grow older, and that females cry oftener than males when evidencing resistive behavior.

Clinging.—'Clinging to the mother,' like crying, occurred throughout the series. Crying, clinging and crying, and 'fixating the object' were the only three patterns tabulated for the six month group. Under clinging, are considered clinging and crying; clinging, not crying; and pressing closely to the

mother (not crying). Clinging without crying first occurred in the twelve month group. It is interesting to note in two other groups, that 'pushing' and 'struggling,' like clinging, first appeared in combination with crying. Clinging reactions were fourth in frequency. Typically in this act a child would tightly embrace the mother's neck and rest its head on her bosom, whence it would or would not yield to the examiner's coaxing.

This response shows a strong sex difference after the 12th month (Table VII.). 21 males as compared with 4 females in the whole series; 12 males, 1 female before the 24th month; 9 males, 3 females after the 24th month.

This is also an innate response judged by the early date of onset. That it can be prolonged (and probably is) by parental guidance may explain this response in some of the older children. Its appearance, so frequently in combination with crying (10 of 25 instances) suggests its primal importance. It and crying are probably the earliest defence mechanisms to appear and are in relation to the mother. As the pattern evolves, we have clinging without crying, and pressing closely (snuggling).

Psycho-analysts will be interested in this sex difference. It is difficult to interpret. A majority of the children studied were the first and only children of young mothers, and it is doubtful that the relative infrequency of clinging on the part of girl babies was in response to a difference in their handling by the mother. There is more likely an innate difference in the infant reaction. In the period 12–23 months, where the contrast is strongest (see Table VII., 11 males, 0 females) the difference is partly made up by 'sole crying' and by 'hiding reactions' on the part of females. The latter responses become increasingly relatively frequent for females with advancing age, suggestive also of innate sex difference.

It would be interesting to observe responses in the father's lap. If clinging on the part of males should have the same frequency in contrast to females, it would establish the innateness of the pattern. (Such observations are not at hand.)

Both crying and clinging may be grouped together as reactions that have chiefly to do with the mother.

"*Merely looks at object*," or "No response, looking at object, but not taking it." This is the third of a list of four reactions observed in the sixth month group. The child fixates the object as in Watson's description of eye-hand-coördination experiments,[1] but does not grasp it. It remains more or less in that position during the entire test. It makes no 'assault' movements on toys or examiner nor any attempt to hide or run away. For that reason it, and similar performances, were grouped together as passive reactions. Fixating occurred in every age group, equally for the sexes, less frequent in the older children. It appeared to be a frequent single response (16 instances).

Fixating the examiner, a similar response, was observed later. *Limp hands* was recorded twice and in the oldest age group (54 months). If objects are put in the child's hands, the hands remain limp and the child will not grasp. It is a direct 'passive' refusal.

(Since all six month children grasp an object, 'fixating only' cannot be explained for the first group on the basis of intelligence. Since the child fixates the object before it grasps it, 'fixating only' indicates that the child stops at the beginning of the test. Just what mechanism is involved at that point is difficult to explain. Commonly the child is described as 'looking stunned' or 'dumb,' it doesn't cry, it merely looks. Of course this may be followed by any other pattern enumerated. At the time of its occurrence, the act is a stopping with no gestures indicating advance or retreat from the situation, analogous to 'blocking' in psychiatry. Making hands or body limp is a common type of resistance in childhood. There were but two instances in this series.)

'*Several Withdrawal Movements with or without Taking the Object.*'—This, the last of the four responses observed in the 6–11 month group was recorded but four times, all before the 20th month. The child's hand goes out to the object, is then withdrawn, then goes out again, etc., ending in withdrawal. It is a hesitation ending in retreat, and the simplest type of

[1] 'Psychology from the Standpoint of a Behaviorist,' Watson, G. B., 1919, p. 275, Lippincott Co., Philadelphia.

withdrawal response listed. All acts similar to a withdrawal movement, e.g. hiding, turning away, etc., may be treated together. Seven patterns are so considered (group 6), 34 instances. The more complex of these appear to be 'the head downward' (described commonly as shy or ashamed), and 'covering the face with the hands' (described commonly as shy, playful, or flirting). Walking back to the mother after completing about half the number of tests occurred but once (a child aged 42 months).

Like crying and clinging this group shows a sex contrast. Excepting in the 6–11 month group where one instance occurred in a male and a female, the contrast became greater with each year group (Table VII.). Of 10 females age 36–47 months, 8 showed some form of 'hiding' reactions. Altogether of 34 such responses 24 were females, 10 males; (after age 24 months, 17 females, 6 males). But more important is the consistency of this contrast in the sexes arranged by age or type of resistance; for example, withdrawal movements, males—1, females—3; head downward, males—0, females—2; covers face with hands, males—1, females—5; looking away, males—2, females—7. Of 10 instances of turning the head away, however, there were 5 males, and 5 females.

(It is unlikely that female children would derive this type of performance from education by parents. Most likely if this contrast holds it is in response to innate structure, though such particular forms as covering the face with the hands may be derived through imitation and the like. One would be tempted to see in this difference an adaptive mechanism favoring the safety from infancy of the female sex, and would expect therefore a preponderance of males in assault reactions. The data available in this paper show no such difference. Males preponderate greatly only in clinging to the mother (21 males, 4 females).)

Screaming and struggling differed from other forms of resistance in that they occurred chiefly on entry before the tests were begun. They represent the most violent type of resistance and show a sex contrast in regard to age occurring typically in the 17–18 month group for females, and in the 30–32

month group for males; that is at the respective peaks of resistance for the sexes as previously determined. Clinging to the mother with or without crying at entry without any recovery for testing occurred in five children of this group—all males.

Of interest is the gradual isolating of struggling from screaming. 'Screaming only' was first noted at 14–15 months, 'screaming and struggling,' 16–17 months; 'struggling only' 26–27 months. Such a transition occurred also with 'clinging' and 'pushing away toys.'

Altogether there were but nine instances of such violent resistance, in the 110 children studied. These forms are regarded as innate.

(It is in this group that one would most likely search for the 'abnormal' child, the reactions being in such marked contrast to the rest and typically according to general observation in 'the spoiled child' or 'child with a bad temper.' In the test situation screaming and struggling are practically unheard of in an unselected group of children over five years of age.)

There remain for consideration *the assault reactions*—actions directed against toys or examiner. Of these the earliest to be recorded was 'pushing toys away and crying,' 12–13 month; 'pushing toys away, not crying,' 16–17 month. Of 11 instances 4 were in males, 7 in females. Slapping movements at examiner was noted also at 16–17 month, actually slapping or pushing the examiner at 26–27 month. (Action directed against examiner 9 instances; 4 males, 5 females.)

'Shaking head' or using words with an equivalent meaning to the examiner were also first noted at 16–17 months, (31 instances, 16 males, 15 females). With the use of language (including shaking the head) comes the commonest type of resistance for children over 24 months of age (a trifle more frequent than hiding reactions), taking the place of crying which is in the lead in the first two years.

(It may be objected to classifying shaking the head and talking with assault reactions. They are similar in that like pushing or hitting they are gestures directed to the toys or to the examiner. Moreover pushing, struggling without crying,

slapping, shaking head and using words all appear about the same time (16–17 months). Slapping and pushing, whether toys or examiner, were not noted after the 41st month, though head shaking and words go on. The latter are really a 'pushing the examiner away' in vocal gestures. This grouping is still problematic, especially 'shaking the head.' It may have the appearance of 'withdrawing' (*e.g.* head rotates to and fro slowly and moves back to mother), though usually not (*e.g.* head shakes vigorously and goes somewhat forward). Head-shaking, however, was not subclassified. It appears about the same time as talking, the latter reactions, though subject also to the same consideration, being more obviously 'aggressive.')

Summary

In further study of resistance in infants and children use was made of the mental-test-situation as a means of eliciting such behavior. The details of the resistance patterns, during mental tests, of one hundred and ten children age 6 to 54 months, were tabulated and distributed according to age and sex. The numerous details fell into eight groups which follow:

1. 'Simple' crying but not struggling or clinging to the mother.
2. Clinging to the mother or pressing closely to her, whether crying also or not.
3. Pushing away toys (and crying or not crying).
4. Slapping movements at or slapping the examiner.
5. Screaming or struggling (or both).
6. Various withdrawal reactions, *e.g.* several hand withdrawal movements, walking back to the mother after partly completing a test, turning the head away to mother, burrowing head in mother, turning head downward, covering the face with the hands, or merely looking away from the test-object.
7. Passive movements, *e.g.* merely fixating the object or the examiner.
8. Head shaking and talking, usually saying, "No! no!"

The most intensive resistant reactions, struggling and screaming, centralized about the eighteenth month for girls and the thirtieth month for boys, in keeping with the high

frequency resistance peaks for each sex as previously determined.

The earliest 'resistances' noted were crying and clinging to the mother (6–7 months). Reactions appearing at first in combination with crying or screaming appeared later in isolated form (*e.g.* clinging to mother, pushing away toys, and struggling). All reactions noted before the fourteenth month, were, in general, crying and withdrawal movements denoting some relation with the mother (excepting pushing away toys with crying at 13 months). At 16–17 months 'assault' reactions, directed to toys or examiner first appeared; also head shaking and speech. Latest to appear were such complex reactions as 'slapping movements without slapping,' 'walking back to mother after partly completing a test,' and 'limp hands' (a single instance, in each).

Crying, the most frequent resistant reaction in the first year gradually diminished in frequency with increasing age (*e.g.* to fifth place at 36–47 months). In contrast speech, including head-shaking, reached first place in frequency within the same period of years. Withdrawal reactions were also very frequent in the period 36 to 47 months. In general the most characteristic group reactions for all age periods in the mental-test-situation were withdrawal plus passive movements

Three significant sex differences were noted:

1. Simple crying after 24 months was more frequent in girls.

2. Withdrawal reactions were more frequently noted in girls in every age period.

3. Clinging to the mother was in sharp contrast, and more frequent in boys.

THE RECOLLECTION OF PLEASANT AND OF UNPLEASANT ODORS

BY KATE GORDON

University of California, Southern Branch, Los Angeles

Are pleasant impressions or unpleasant ones the more likely to be recalled? This question has occasioned much psychological discussion, and has stimulated a few experimental inquiries. It is not within the purpose of this article to review or to criticize previous work done, except to remark that in some of the studies of affective memory the agreeable and disagreeable experiences to be recalled have not been produced under observed conditions, nor judged as agreeable or disagreeable at the time of the experience. The experiment to be reported does fulfil these conditions.

Materials Used

Ten different odors were selected, which seemed (to 3 observers) to offer a wide range of affective quality, and which seemed to be as equal as possible in intensity. The odors were lemon, cinnamon, peppermint, bergamot, lavender, eucalyptus, tansy, creosote, valerian and asafœtida. They were in liquid form, most of them being the essential oils.

The odorous substances were contained in a series of half-ounce bottles, each of which was half filled. These bottles were uniform in size and shape, and white paper was pasted around them in order to conceal the contents. Each bottle had a screw top and a cork. The cork was pierced by a needle and had a thread drawn through it. One end of the thread rested in the liquid and the other reached into the space between the cork and the cap. The cork was pushed down into the neck of the bottle far enough to leave a small air chamber between the cork and the cap, and the thread acted as a miniature wick feeding into this chamber. When the cap was unscrewed one could smell the contents of the bottle

without removing the cork. (I am indebted to Dr. Carl Johnson for this simple and effective device.) In addition to the bottles containing odors ten others were prepared which were similar in appearance but which held only water. The use of these is explained below.

Procedure

The order in which these bottles were set out for the persons tested requires a somewhat extended explanation. Suppose a person to have smelled the ten odors. How are we to know which ones he can recall? This might be done by requiring him to recognize these odors when presented among a larger number of other odors. This plan was rejected for two reasons; first because of the fatigue which could be anticipated in the smelling of forty or fifty 'confusion' odors, and second because of the labor to the subject of handling so many bottles. An alternative plan is to require the subject to tell what odors he has experienced and to locate them in the series. In this case names or numbers must be supplied to the subject by which he may designate the odors. Preliminary trials showed that, unless the true odor names were given, the subject was much preoccupied in trying to think of them for himself. The interest in identifying the odor was a distraction from the experiment. It was decided, therefore, to allay curiosity by using the true names, and to pronounce them at the moment when the odor was being perceived.

It is clear, nevertheless, that the names of the odors chosen are different in length, and, as events proved, they were quite different in degree of familiarity to the subjects. There was needed, therefore, some way of estimating the difficulty of recalling the names independently of the odors.

The idea suggested itself of having the subject open a series of empty bottles and hear one of the names pronounced in connection with each bottle, and then to test his recollection of the series. But the futility of opening a whole series of non-odorous bottles would be apparent to the subject, and the expectation would be essentially different from that in the odorous series. It was decided to give the subject each name

once in connection with its proper odor, and once in connection with a non-odorous bottle, but to intersperse the blank bottles among the others in irregular order. Each subject was thus asked to smell of twenty bottles, in ten of which he would find odor. The twenty bottles were arranged in two series. The subject, seated at a table with the first series before him, was instructed orally as follows:

> This is an experiment on the memory for the names of certain odors. When the signal "Go" is given, you are to take up the first little bottle on your left, unscrew the top (the experimenter illustrates), take one good smell, then screw on the top, put the bottle down and take up the next. Work through the ten bottles without pausing. As you smell of each bottle I will pronounce the name of the odor that belongs in it. In some cases the odors will really be present in the bottles, but in some cases they will not. Whether the odor is there or not you are to remember as many of the names as you can and to point to the places where they belong. Ready. Go.

When the last of the ten bottles had been opened and smelled, and replaced, the experimenter said: "Give all the names you can and point to the bottles where they belong." The experimenter wrote down the replies. The subject was then asked to change his position and to sit at another side of the table where another ten bottles, at right angles to the first series stood in order. This change was made so that each series should have a distinct spatial association. The experimenter then said: "The procedure is the same for the second series, except that the order has been changed. Different bottles have odors and different ones are blanks, but a name will be given each time you open a bottle and you are to remember all you can. Ready. Go."

After the second series had been recalled and recorded, all of the bottles which contained odors, *i.e.* ten in all, were assembled in front of the subject and he was requested to arrange them in an order of merit according to their agreeableness and disagreeableness. This was to be done on the basis of his personal preference, the one he liked best being put first, his second choice second, and so on. He was allowed to smell them several times if necessary in order to make a decision. He was at liberty to class all of them as pleasant or all as unpleasant if he so desired, but in case there was a distinction he was to indicate where the division came between

the ones he liked and those he disliked. Sample arrangements as made by the subjects will illustrate this point. The three lists here given show the order of preference for three subjects.

Subject I	*Subject II*	*Subject III*
1. cinnamon	1. peppermint	1. lemon
2. lemon	2. lemon	2. cinnamon
3. bergamot	3. bergamot	3. bergamot
4. lavender	4. tansy	4. peppermint
5. tansy	5. lavender	5. lavender
6. peppermint	6. cinnamon	6. eucalyptus
7. creosote	7. eucalyptus	7. tansy
8. eucalyptus	8. valerian	8. valerian
9. valerian	9. creosote	9. asafœtida
10. asafœtida	10. asafœtida	10. creosote

In the case of Subject I. six odors were judged to be pleasant and four unpleasant. Subject II. found four pleasant, one doubtful and five unpleasant. Subject III. thought five pleasant and five unpleasant. The position of the 'indifference line' or an 'indifference zone' was recorded in each case.

The arrangement of bottles as set out for the first part of the memory experiment is shown in Table I.

TABLE I

FIRST ARRANGEMENT OF BOTTLES

*1. lemon	1. bergamot
2. eucalyptus	*2. lavender
*3. creosote	3. asafœtida
*4. bergamot	4. tansy
5. peppermint	*5. valerian
*6. asafœtida	6. lemon
7. lavender	*7. eucalyptus
8. cinnamon	*8. peppermint
*9. tansy	9. creosote
10. valerian	*10. cinnamon

The items in the series which are starred are those representing the bottles which actually contained the odors, whereas the

names not so marked were given in conjunction with the empty bottles. The names which in the left-hand series accompany odors, are given with empty bottles in the right-hand series. This arrangement, as in Table I., was used for the first 20 subjects. In the case of 10 subjects the left-hand series was presented first and the right-hand series second, and in the case of the other 10 subjects the right-hand series was given first.

Now it is well known that when items are learned in a series there is a considerable advantage accruing from certain of the positions. The likelihood of recall is greater for the initial item, for instance, than it is for the middle one. It is apparent, for this reason, that the name 'Lemon' has an advantage of position in the left-hand series which it does not have in the right, and that 'Bergamot' has a similar advantage in the right-hand series but not in the left. In order to eliminate such inequalities it was necessary to use a sufficient number of different arrangements to allow each bottle to occupy, in turn, each of the possible positions in each of the series. The manner of rotating the positions to effect this end is shown in Table II., which exhibits the arrangement used with the second squad of 20 subjects.

TABLE II

SECOND ARRANGEMENT OF BOTTLES

1. eucalyptus	*1. lavender
*2. creosote	2. asafœtida
*3. bergamot	3. tansy
4. peppermint	*4. valerian
*5. asafœtida	5. lemon
6. lavender	*6. eucalyptus
7. cinnamon	*7. peppermint
*8. tansy	8. creosote
9. valerian	*9. cinnamon
*10. lemon	10. bergamot.

In this arrangement, as compared with the previous one, the bottle containing lemon has been moved to the bottom of the left-hand series, and all other bottles have been moved up one

step each towards the top. In the right-hand series the blank bottle named bergamot has been moved to the bottom, and all others in this list advanced one step upwards.

One more arrangement is presented in Table III. in order to make entirely clear the method of rotating these bottles.

Table III

Third Arrangement of Bottles

*1. creosote	1. asafœtida
*2. bergamot	2. tansy
3. peppermint	*3. valerian
*4. asafœtida	4. lemon
5. lavender	*5. eucalyptus
6. cinnamon	*6. peppermint
*7. tansy	7. creosote
8. valerian	*8. cinnamon
*9. lemon	9. bergamot
10. eucalyptus	*10. lavender

In this third arrangement the bottle containing lemon has now advanced to position nine in the left-hand series, all above it likewise advancing one step, and the blank bottle named eucalyptus has dropped from first to last place. By pursuing this plan, as will be seen, each of the odors will eventually have occupied each of the possible positions, as will also each of the blank bottles. The advantage derived from position is thus equalized, in the long run, among all the bottles. Ten such arrangement were used, and 20 persons tested on each arrangement, thus giving results with 200 subjects.

The persons who acted as subjects in the tests were 3 instructors and 197 students in the psychology classes of the University of California, Southern Branch. Eleven were men and 189 women.

The Results

The Affective Value of the Odors.—The first question to be determined is: Did the subjects really experience agreeableness and disagreeableness from the odors? The chief meaning of the experiment rests upon the answer to this question. In

fact not one of the 200 subjects failed to report an affective response, and, judging by incidental comments as well as by the expression of the faces, this was sometimes very marked. There was a considerable amount of variation in the exact order of merit in which different observers arranged the odors, but there was also a marked preponderance of choice for certain ones. Nearly everyone classed lemon as pleasant, and everyone classed asafœtida as unpleasant, although the precise position varied in both cases. The relative preferences can be shown by constructing a diagram, for each odor, of the distribution of the positions to which it was assigned by the various observers. Fig. 1 shows these distributions.

The ten diagrams, beginning with the left on the upper row, are arranged in an order of merit secured by averaging the judgments of all the subjects. The numbers on the ordinates indicate the number of persons passing certain judgments. The numbers on the abscissas stand for the different ranks in affective worth. For example, in the diagram labelled 'Lemon,' the first column at the left shows that 84 persons judged the odor lemon to be the best of all, *i.e.* they gave it first place in the series. The second column shows that 51 persons gave it second place. There were 36 who gave it third place, and so on down to 8 who gave it sixth place. Lower than this it was never ranked. An average of all the positions assigned to lemon gives the number 2.175, and this is the highest average rank of all. The odor ranking lowest is asafœtida. One person gave it fifth place, and this was the highest it ever received. Its average rank is 9.53, and there were 139 persons who gave it tenth place.

The rank order of agreeableness as estimated by the first 100 subjects was compared with the rank order as estimated by the second 100 subjects and the two proved to be identical.

While the order of merit tells us something about the relative affective values of the odors, it does not tell us how many of them were felt to be pleasant and how many were unpleasant. The odor bergamot, for example occupies fourth place in the average series. It is liked, on the whole, a little better than lavender, and not so well as peppermint, but this

does not determine whether it is pleasant or unpleasant. One person might like the first three of the series and dislike the last seven, whereas another might like the first four and dislike the last six. In such a contingency the odor which was pleasant for the one and unpleasant for the other would yet be ranked the same. For the sake of understanding our results it is, then, necessary to know exactly how many judgments of 'pleasant,' 'unpleasant,' and 'indifferent or doubtful' there are to be considered.

Some of the subjects classified 5 odors as pleasant and 5 as unpleasant; some thought 4 pleasant and 6 unpleasant: others called 4 pleasant, 2 indifferent, and 4 unpleasant; still others found 6 pleasant and 4 unpleasant, and so on through many variations. Inasmuch as the 200 subjects each judged the 10 odors, we have a total of 2,000 judgments to be classified. Of this number there were 1,020 reported as pleasant, 882 unpleasant, and 98 indifferent.

The Recollection of the Pleasant, Unpleasant and Indifferent.—The rule observed in scoring the subject's recollections was to count 'one' for each name correctly located in the series of bottles. No partial credits were given. A sample record here follows:

Names Recalled		Order of Agreeableness
1. lemon	1. bergamot	1. cinnamon
2. eucalyptus	2. lavender	2. eucalyptus
3. creosote	3. asafœtida	3. peppermint
4. bergamot	4. lemon —	4. bergamot
5. cinnamon —	5. valerian	5. lemon
6. asafœtida	6. eucalyptus —	6. lavender
7. lavender	7. peppermint —	7. tansy
8.	8. lemon —	8. creosote
9.	9.	9. valerian
10. tansy —	10. cinnamon	10. asafœtida

A comparison of this record with the actual order of impressions as shown in Table I. brings out the fact that 6 items of the left-hand series and 5 items of the right-hand series were correctly named and located. (A dash occurs after the items incorrectly located in the above record.) Among the 11 bottles rightly remembered the following really contained odors: lemon, creosote, bergamot, asafœtida, lavender, va-

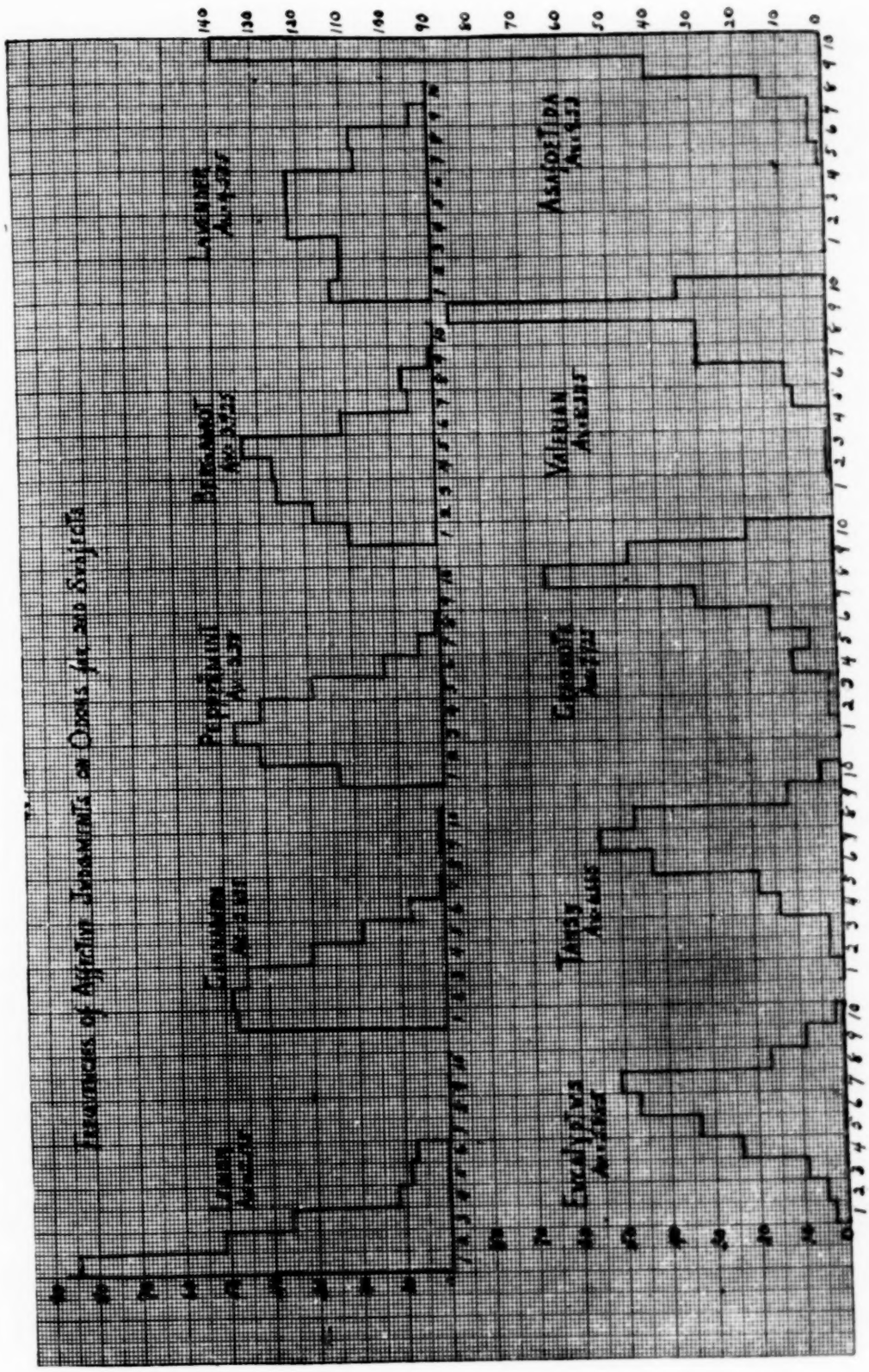
Frequencies of Adjective Judgments on Odors for 20 Subjects
Lavender
Asafoetida
Peppermint
Valerian
Eucalyptus
Camphor
Thyme

FIG. 1

lerian and cinnamon. Of these 7 odorous bottles rightly remembered we may now see which were pleasant and which unpleasant. Reference to the order of agreeableness for this subject, as given in the last column at the right in the above quoted record, shows that lemon, bergamot and cinnamon were among the pleasant, whereas creosote, asafœtida, lavender and valerian were classed as unpleasant. In other words, 3 of the agreeable odors and 4 of the disagreeable were correctly recalled.

Another illustrative record reads as follows:

Names Recalled		Order of Agreeableness
1. lemon	1.	1. cinnamon
2. bergamot —	2. verbena —	2. lemon
3.	3. asafœtida	3. bergamot
4.	4.	4. lavender
5. peppermint	5.	5. tansy
6. asafœtida	6. valerian —	6. peppermint
7.	7. lemon —	7. creosote
8. tansy —	8. eucalyptus —	8. eucalyptus
9.	9. creosote	9. valerian
10. valerian	10. cinnamon	10. asafœtida

This subject puts in a name not used in the real series, namely, verbena, as well as making wrong locations and having several omissions. However, he places 7 items correctly, and of these 7 the following 3 were connected with odors: lemon, asafœtida and cinnamon. Referring to the order of agreeableness for this subject, we find that of the 3 odors remembered correctly 2 were agreeable and 1 was disagreeable.

The inequalities of position are not eliminated in the case of the individual subject. Thus, in the arrangement just given, the odor lemon has an advantage over asafœtida, due to the fact that the former is first, and the latter is sixth in the series. It may well be that with the individual the pleasant or unpleasant would occasionally have an advantage of position. But such inequalities disappear when the whole number of subjects is taken together. By adding together all of the pleasant impressions correctly recalled we get a total of 500. The whole number of pleasant impressions experienced was 1,020 (see above). Hence, of all the pleasant odor experiences 49 per cent. were correctly recalled. Adding up the

unpleasant impressions correctly recalled we get a total of 445, which is 50 per cent. of the 882 unpleasant impressions experienced. Of the 98 impressions rated as indifferent, 55 were correctly recalled, *i.e.* 56 per cent. These results thrown into tabular form are, Table IV.

TABLE IV

	Odor Experiences Classified as		
	Pleasant	Indifferent	Unpleasant
Experienced	1,020	98	882
Recalled	500	55	445
Per cent. recalled	49	56	50

In the above summary of results no account has been taken of the factor of familiarity with the various odor names. This influence will be dealt with more exactly below, but it may be remarked here that the subjects frequently commented on their lack of familiarity with the names, bergamot, creosote, tansy, valerian and asafœtida. It so happens that the bergamot is generally found pleasant, and the other four unpleasant. Hence it would seem that the factor of familiarity favors the group of pleasant odor names.

In order to determine more precisely just what was the effect of the names upon the success of the recollections, it is necessary to turn to the results with the non-odorous bottles.

Recollection of Odor Names With and Without Sensory Accompaniment.—In the case of each odor name two curves have been constructed. The first shows how many times that name was correctly recalled and placed when it had been conjoined with its proper odor; the second shows how many times the name was recalled when connected with an empty bottle. In Figure 2 a pair of diagrams is given for each odor name. The frequency surfaces occupying the left half of Fig. 2 show the number of times each name was remembered when associated with its appropriate odor, whereas the surfaces of the right half of the figure show the number of times each name was recalled when it had been given in association with one of the empty bottles. The numbers on the abscissas indicate the different

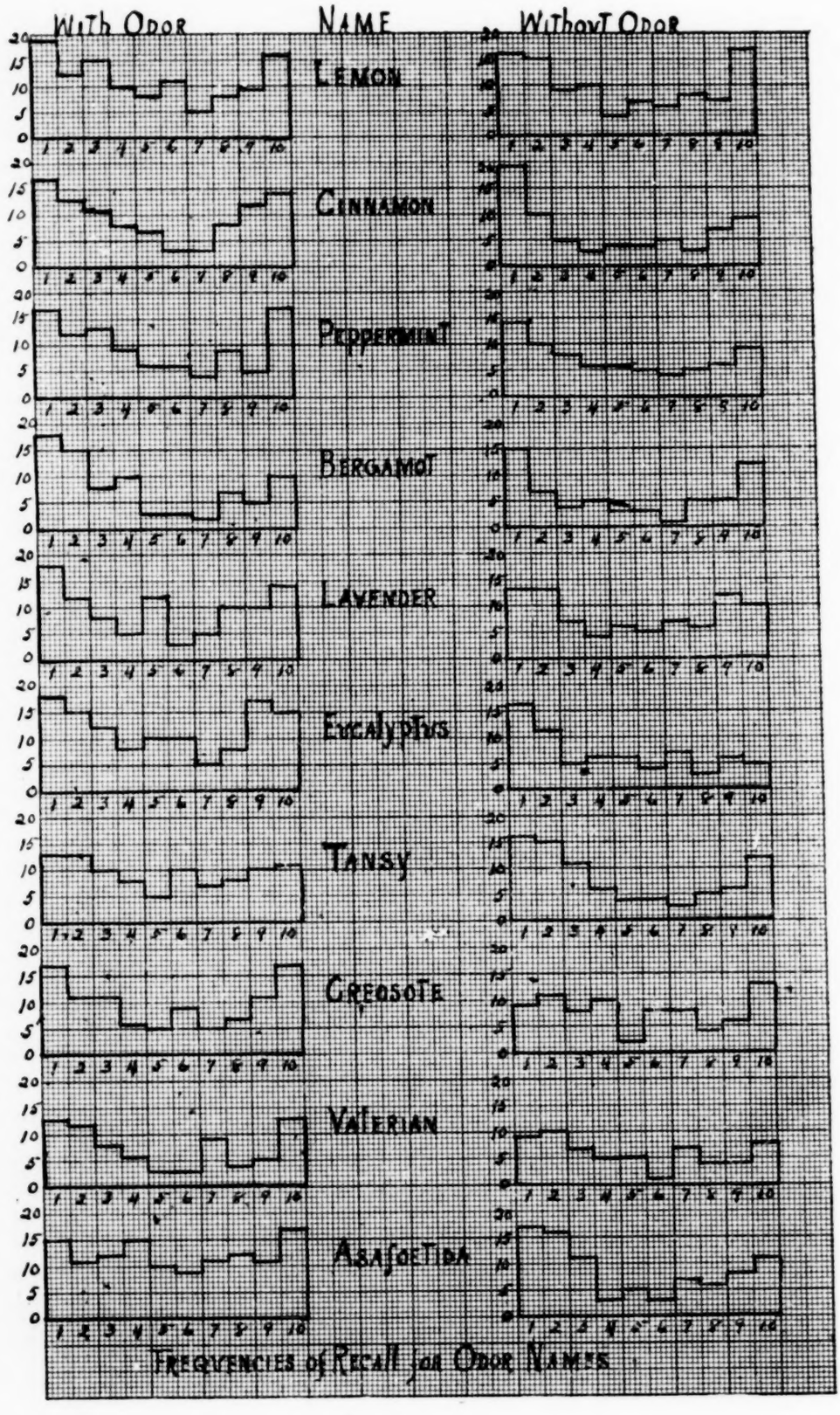
With Odor
Name
Without Odor
Lemon
Cinnamon
Peppermint
Bergamot
Lavender
Eucalyptus
Tansy
Creosote
Valerian
Asafoetida
Frequencies of Recall for Odor Names

Fig. 2

serial positions. The numbers on the ordinates stand for the number of persons who recalled the odor name in any given position. For instance, the diagram in the upper left-hand corner indicates that when the odor lemon occupied position number 'one' in the series of bottles, it was correctly remembered by 19 persons (out of a possible 20). When lemon occupied the second position in the series, (see column '2') it was correctly remembered by 12 persons out of 20. When it occupied third place (column '3') it was remembered by 15 persons out of 20, etc. This diagram, therefore, tells how many times altogether the name of lemon was recalled when it had been experienced with its proper odor. The highest number of times possible under the conditions of the experiment is 200. If we add together the total recalls irrespective of the positions we find 113. Turning now to the first frequency surface in the upper right hand corner, we see the number of times that the name of lemon was recalled when it had been heard in connection with one of the empty bottles. When presented as first in the series (column '1') it was recalled by 16 persons out of 20. When in the second position it was recalled by 15 persons, etc. The total number of correct recalls shown in this case is 99. The difference between the two totals, *i.e.* 113 minus 99, or 14, is a difference which it seems fair to attribute to the presence of the odor.

The two diagrams next below, in Fig. 2, represent the recalls for cinnamon. The total number of persons recalling it when the odor was present (see diagram on the left) was 96, and the total number recalling it without the odor (see diagram on the right) was 69. The difference between 96 and 69, *i.e.* 27, we attribute to the effect of the odor cinnamon.

The numerical results of such a comparison of the ten pairs of diagrams are thrown together into Table V.

At the left are the names of the odors. In column 'I.' are the numbers of times they were recalled when associated with the olfactory sensation, and in column 'II.' the numbers of times they were recalled when unassociated with odor. In the last column are the differences between columns I. and II., and to these numbers we give the name of 'memorial values'

or 'coefficients' of the odors, inasmuch as these are the differences which remain after we have eliminated inequalities of position and of name.

TABLE V

MEMORIAL VALUES OF ODORS

Name	Number of Times Recalled		Difference between I. and II.
	I. With Odor	II. Without Odor	
Lemon	113	99	14
Cinnamon	96	69	27
Peppermint	98	73	25
Bergamot	81	60	21
Lavender	97	83	14
Eucalyptus	118	69	49
Tansy	95	82	13
Creosote	99	79	20
Valerian	76	60	16
Asafœtida	123	87	36
Average	99.6	76.1	23.5

The memorial values are positive in each instance, *i.e.* the actual presence of the odor assisted in fixing its name in mind in the case of all ten of the odors. The average of column I. is 99.6, the average of column II. is 76.1 and the average difference is 23.5. The latter number is 30.8 per cent. of 76.1. Hence we may say that in this series the effectiveness of a name for recall is enhanced approximately 31 per cent. by the presence of the odor, although the odors differ considerably in this power.

We are now in position to inquire whether those odors which the group judges to be pleasant are more effective in promoting recall than those which are judged to be indifferent or unpleasant.

Memorial Value of Pleasant, Indifferent and Unpleasant.— Inspection of the list in Table V. (which is arranged according to the order of agreeableness of the odors as set forth in Fig. 1) shows that lemon, the best of the odors, is not so likely to promote recall as asafœtida, which is the worst. The memorial value of lemon is 14 and that of asafœtida is 36. On the other hand, cinnamon, which is the second best odor, has a higher memory value, namely 27, than the next to the worst

odor, valerian, which has a value of 16. Were we to take the sum of the values of the first five odors, and compare it to the sum of the values of the last five odors, we would find 101 for the former and 134 for the latter. From this it would appear that the unpleasant odors have the more effect for recall. But this result seems to the writer unconvincing for two reasons. First, there is no consistent trend apparent in the series from first to last. Second, the odor which has the highest value of all, namely, eucalyptus, stands in the middle of the series close to the indifference line. A different approach is desirable.

Correlation of Affective Order and Memory Order.—It is feasible to arrange the series of odors in an order of merit according to the memorial values as found in Table V. This gives us eucalyptus first, asafœtida second, cinnamon third, and so on with tansy last. Correlating this order with the order of agreeableness as previously given, and using the formula

$$r = 1 - \frac{6 \text{ Sum } D^2}{n(n^2 - 1)}$$

we arrive at a coefficient of $-.07$, or practically a zero correlation.

Our conclusion from this part of the experiment is that pleasant odors are not more likely to be recalled than the unpleasant. If any difference has been shown, it is in favor of the unpleasant, but we are inclined to doubt the validity of this difference. We must search for other factors than affective tone if we would understand why some impressions are recalled and others are not.

Summary

I. Of 1,020 pleasant impressions experienced 49 per cent. were recalled. Of 882 unpleasant impressions 50 per cent. were recalled, and of 98 'indifferent' ones 56 per cent. were recalled.

II. The presence of odor exerted a positive influence in promoting recall of odor names.

III. No correlation was found between the memory value of odors and their affective value.

AN EXPERIMENTAL STUDY OF THE PERCEPTION OF FILLED AND EMPTY TIME

BY EDGAR JAMES SWIFT AND JOHN ALEXANDER McGEOCH

Washington University

The purpose of this investigation was to determine the general, individual and sex differences in the estimation of intervals of time ranging from thirty seconds to ten minutes, under the following conditions.

First, empty time; the subjects sat quietly, doing nothing.

Second, time filled; the subjects were occupied in various ways, copying nonsense syllables, uninteresting sense material, an interesting incident from 'Huckleberry Finn,' and, finally, listening to the reading of another anecdote from the same story. The 'dry material' was from the catalogue of the Engineering School of Washington University. The portions selected were descriptions of the laboratory equipment, and since the subjects were not engineering students, this material was thought to be reasonable 'dry,' especially when compared with two of the most amusing pages of Mark Twain's 'Huckleberry Finn' which served as the 'interesting' material for both the copying and listening to what was read. The reading was done by the two experimenters in their several sections of the class in elementary psychology and the usual devices of those who read aloud for adding to the interest of humorous selections were adopted by the readers so far, at least, as they were capable of utilizing them.

The subjects were college students of the various sections of the first year in psychology, and the time was controlled by a stopwatch.

The students were not aware of the purpose of the investigation beyond knowing that we wished to get their estimate of time intervals under varying conditions. At the time when the experiments were made the subjects knew nothing about the earlier experiments which indicate that empty time seems longer than filled time.

The number of subjects considered in this report includes 123 men and 104 women, except for the 10-minute estimates when the number was as follows:

	Men	Women
Copying 'Huckleberry Finn'	162	141
Copying nonsense syllables	160	137
Copying dry material	156	140
Hearing 'Huckleberry Finn' read	153	132

The figures given in the tables are averages and are expressed in decimals of a minute.

TABLE I

COMPARATIVE ESTIMATES OF FILLED AND EMPTY TIME[1]

	30 Sec. Full	30 Sec. Empty	1 Min. Full	1 Min. Empty	2 Min. Full	2 Min. Empty	5 Min. Full	5 Min. Empty
Men	.833	.690	1.470	1.869	3.48	3.195	6.50	7.04
S. D.	.455	.310	.610	1.120	1.83	1.520	2.61	2.94
Women	.783	.738	1.545	1.853	3.38	3.180	6.30	6.20
S. D.	.393	.364	.631	1.065	1.70	1.620	2.61	2.23

TABLE II

COMPARATIVE ESTIMATES OF FILLED AND EMPTY TIME BY AGES—MEN

Age	Cases	30 Sec. Full	30 Sec. Empty	1 Min. Full	1 Min. Empty	2 Min. Full	2 Min. Empty	5 Min. Full	5 Min. Empty
17	4	.81	.63	1.20	2.00	3.00	3.20	6.50	7.50
18	15	.853	.64	1.61	1.90	3.80	3.10	7.40	7.70
19	29	.76	.68	1.41	1.79	3.36	3.32	6.53	7.07
20	24	.82	.72	1.53	1.69	3.60	2.91	5.81	7.12
21	17	.95	.58	1.49	1.99	3.30	3.21	6.37	6.79
22	6	.84	.51	1.37	2.10	3.50	3.60	6.80	6.60
23	3	.88	.86	1.16	2.30	4.30	3.55	7.66	5.60
24	5	1.10	.91	1.90	2.10	3.30	3.60	6.60	7.20
25	4	.81	.66	1.31	1.87	3.00	3.18	6.20	7.25
26	4	1.06	.81	2.06	2.29	3.70	3.25	6.75	6.00
27–35	12	.65	.67	1.25	1.68	3.33	3.30	6.50	6.91

[1] The filled time was occupied with listening to uninteresting material from the engineering catalogue.

TABLE III

COMPARATIVE ESTIMATES OF FILLED AND EMPTY TIME BY AGES—WOMEN

Age	Cases	30 Sec. Full	30 Sec. Empty	1 Min. Full	1 Min. Empty	2 Min. Full	2 Min. Empty	5 Min. Full	5 Min. Empty
16.....	2	.550	.500	1.750	1.40	5.00	3.60	5.0	7.5
17.....	3	.766	.916	1.430	1.83	3.80	3.20	6.0	7.3
18.....	12	.693	.566	1.580	1.62	2.90	3.00	7.0	5.9
19.....	38	.733	.720	1.421	1.83	3.10	2.89	5.6	5.6
20.....	22	.760	.738	1.600	1.83	3.40	3.10	6.4	6.2
21.....	14	.910	.758	1.528	2.15	3.78	3.60	7.0	6.5
22.....	9	.841	1.158	1.740	1.83	3.50	3.66	8.3	6.5
23.....	4	1.000	.583	1.750	2.25	3.50	3.75	5.0	8.7

TABLE IV

COMPARATIVE AMOUNTS OF OVER- AND UNDERESTIMATION OF FILLED AND EMPTY TIME

	30 Sec. Full		30 Sec. Empty		1 Min. Full		1 Min. Empty		2 Min. Full		2 Min. Empty		5 Min. Full		5 Min. Empty	
	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
Men.....	.350	.017	.220	.030	.520	.05	.888	.019	1.483	.003	1.207	.022	1.80	.30	2.20	.16
Women...	.300	.017	.266	.028	.585	.04	.865	.012	1.420	.040	1.250	.070	1.70	.40	1.50	.30

TABLE V

PERCENTAGES OF CORRECT ESTIMATES—MEN

Age	30 Sec. Full	30 Sec. Empty	1 Min. Full	1 Min. Empty	2 Min. Full	2 Min. Empty	5 Min. Full	5 Min. Empty
17.....	.25	.25	.000	.250	.000	.000	.250	.250
18.....	.20	.266	.133	.133	.200	.200	.200	.000
19.....	.307	.275	.137	.102	.034	.102	.307	.206
20.....	.291	.375	.208	.166	.125	.166	.166	.250
21.....	.117	.529	.176	.588	.588	.117	.176	.294
22.....	.165	.500	.333	.000	.166	.000	.166	.666
23.....	.333	.000	.333	.000	.333	.000	.000	.000
24.....	.400	.200	.400	.000	.000	.200	.200	.400
25.....	.500	.250	.250	.250	.250	.000	.000	.000
26.....	.250	.250	.000	.000	.000	.000	.000	.500
27–35.....	.333	.333	.083	.166	.333	.166	.660	.333
General average.....	.268	.333	.178	.113	.122	.122	.194	.260

TABLE VI

PERCENTAGES OF CORRECT ESTIMATES—WOMEN

Age	30 Sec. Full	30 Sec. Empty	1 Min. Full	1 Min. Empty	2 Min. Full	2 Min. Empty	5 Min. Full	5 Min. Empty
16	.500	1.000	.000	.500	.000	.000	.500	.500
17	.333	.000	.000	.333	.000	.333	.000	.000
18	.416	.416	.333	.250	.166	.333	.250	.500
19	.526	.394	.345	.260	.157	.260	.394	.342
20	.590	.363	.227	.227	.136	.227	.272	.454
21	.428	.357	.357	.144	.144	.071	.071	.357
22	.555	.333	.444	.333	.222	.222	.111	.333
23	.000	.750	.250	.000	.000	.000	.500	.250
General average.	.490	.394	.307	.240	.144	.221	.288	.375

TABLE VII

COMPARATIVE ESTIMATES OF FOUR 10-MINUTE PERIODS DIFFERENTLY FILLED

	Copying Dry Material	Copying Nonsense Syllables	Copying from 'Huck Finn'	Listening to Mark Twain
Men	9.65	8.50	9.29	12.20
S. D.	2.52	3.34	2.88	3.24
Women	9.62	9.18	9.10	12.32
S. D.	2.80	2.75	3.10	3.29

TABLE VIII

COMPARATIVE ESTIMATES BY AGES OF FOUR 10-MINUTE PERIODS DIFFERENTLY FILLED—MEN

Age	Cases	Copying Dry Material	Cases	Copying Nonsense Syllables	Cases	Copying from 'Huck Finn'	Cases	Listening to Mark Twain
17	4	10.00	3	7.30	3	10.60	4	13.00
18	20	10.40	20	7.20	20	8.90	18	12.70
19	37	9.04	38	8.40	36	9.22	38	12.16
20	32	9.82	32	8.85	34	9.35	31	12.48
21	22	10.03	23	8.66	21	10.61	22	12.00
22	6	10.00	7	8.42	7	7.50	5	11.20
23	4	7.00	3	11.60	4	9.25	3	13.30
24	4	10.20	6	9.00	5	7.80	4	12.20
25	5	10.10	5	9.40	7	10.10	6	11.30
26	7	10.50	7	7.50	8	9.56	6	12.10
27–35	15	9.00	16	9.31	17	8.50	16	12.06

TABLE IX

COMPARATIVE ESTIMATES BY AGES OF FOUR 10-MINUTE PERIODS DIFFERENTLY FILLED—WOMEN

Age	Cases	Copying Dry Material	Cases	Copying Nonsense Syllables	Cases	Copying from 'Huck Finn'	Cases	Listening to Mark Twain
16....	2	8.00	2	5.40	2	11.0	2	15.0
17....	7	10.50	6	11.00	6	9.2	7	12.6
18....	17	11.00	14	9.6	15	7.9	16	14.8
19....	53	9.20	48	9.0	53	8.8	47	12.4
20....	30	9.70	32	9.2	32	10.0	29	11.8
21....	18	9.61	20	7.7	19	9.15	16	11.81
22....	8	8.62	9	7.66	10	7.9	10	10.5
23....	5	9.60	5	7.4	4	9.75	5	12.2

TABLE X

COMPARATIVE AMOUNTS OF OVER- AND UNDERESTIMATION OF FOUR 10-MINUTE PERIODS DIFFERENTLY FILLED

	Copying Dry Material		Copying Nonsense Syllables		Copying from 'Huck Finn'		Listening to Mark Twain	
	+	−	+	−	+	−	+	−
Men.....	.84	1.19	.60	2.10	.81	1.52	2.4	.20
Women.....	.80	1.18	.70	1.52	.80	1.70	2.59	.27

TABLE XI

PERCENTAGES OF CORRECT ESTIMATES—MEN

Age	Copying Dry Material	Copying Nonsense Syllables	Copying from 'Huck Finn'	Listening to Mark Twain
17.....	1.00	.333	.666	.25
18.....	.35	.20	.400	.377
19.....	.324	.289	.222	.315
20.....	.216	.156	.411	.096
21.....	.318	.347	.426	.227
22.....	.75	.284	.284	.400
23.....	.25	.000	.500	.500
24.....	.50	.50	.400	.250
25.....	.20	.000	.284	.660
26.....	.142	.284	.500	.333
27–35.....	.266	.125	.411	.250
General average.	.320	.243	.373	.241

TABLE XII

PERCENTAGES OF CORRECT ESTIMATES—WOMEN

Age	Copying Dry Material	Copying Nonsense Syllables	Copying from 'Huck Finn'	Listening to Mark Twain
16	.000	.000	.500	.000
17	.428	.333	.333	.142
18	.411	.500	.333	.253
19	.334	.416	.434	.229
20	.466	.281	.312	.345
21	.277	.350	.526	.374
22	.000	.555	.200	.400
23	.600	.600	.250	.200
General average.	.357	.389	.382	.295

CONCLUSIONS

In view of the statements usually made regarding the estimation of filled and empty time some rather striking results are indicated by this investigation. Under the conditions of the experiment the following conclusions seem warranted.

1. The 30 sec., 1 min., 2 min., and 5 min. periods are overestimated by both men and women irrespective of ages and regardless of whether the intervals are filled or empty.

2. It is doubtful whether there is any difference between empty time of these durations and the same periods filled with listening to uninteresting sense material. The reason for making this statement is that while both the empty and filled periods are consistently overestimated by both the men and women, the excess of overestimation in the case of the men alternates between filled and empty time from the 30 sec. period to 5 minutes. For the 30 sec. period, with the men, as will be observed, the overestimation is greater by .143 min. for the filled than for the empty time, for the 1 min. period the overestimation is greater by .399 min. for the empty time, for the 2 min. period, again, the overestimation is greater by .295 min. for the filled time, and finally, for the 5 min. period the overestimation is greater by .54 min. for empty time. It is worth noting however, that, considering the averages, all of the men overestimated 30 sec. filled by

.143 min., and that the same men overestimated 1 min. empty by .399 min.

It is also interesting to observe that the overestimation and underestimation by the women of filled and empty 30 sec., 1 min., and 2 min. periods varies in exactly the same way as that of the men, but in the 5 min. period the overestimation of the men was greater by .54 min. for the empty time and that of the women by .1 min. for full time.

In the comparative estimate of filled and empty time by ages, one might feel inclined to stress the rather noticeable increase in the estimation of the filled 30-sec. period for men at about the age of 24 years were it not for the reversed estimate for 1 min. and the lack of any very satisfactory corroborating evidence for the longer periods given in Table II. One is inclined to wonder, also, whether the rather closer agreement between the estimates by men of filled and empty time at about the age of 27 should be stressed. On the whole, however, there does not seem to be any convincing evidence of differences which can be attributed to sex or, indeed, to age, within the limits of this investigation.

From Table IV. we see that the amount of overestimation of 30 sec., 1 min., 2 min., and 5 min. periods, both filled and empty is always greater than the amount of underestimation for corresponding times.

As seen in Tables V. and VI. there is considerable variation in the percentages of correct estimates among the different ages for both men and women, but these variations are so distributed that it is impossible to say that either men or women are more accurate in their estimates at one age than at another. The general average of correct estimates, in percentages, for the women, however, is greater for all of the periods both full and empty than for the men. And in all but one instance the percentage of correct estimates of the women is markedly greater. The general average of correct estimates, for the eight periods estimated is for the women .307 min. and for the men .197 min.

The 10 min. period was filled in four different ways: copying dry material from the catalogue of the Engineering

School, copying nonsense syllables, copying one of the humorous anecdotes from 'Huckleberry Finn,' and, finally, listening to another of the humorous stories in that book.

Perhaps the most striking fact observed in the study of the ten minute periods filled in these various ways is the overestimation of time, as seen in Table VII., while the subjects were listening to the reading of one of the most humorous of all of Mark Twain's laughter-provoking anecdotes. It was the description of the way in which Huckleberry Finn frightened the men who were looking for their runaway slave by intimating that the man on the raft was afflicted with smallpox. Both the men and women overestimated the ten minutes during the period of physical inactivity while they underestimated the same length of time when engaged in copying dry sense material, nonsense syllables, and another of the humorous stories from 'Huckleberry Finn.' It may be said, then, that the time seems shorter than the actual time when the subject is doing something even if the task is uninteresting; and a ten minute period spent in listening to reading, even though the material is humorously interesting, is perceived as longer than the actual time.

The same period of time occupied in copying seemed shorter than the actual time, as we have just said, for both men and women. For the men the time spent in copying nonsense syllables seemed, in general, shorter than the same interval occupied in copying from 'Huckleberry Finn.' For the women, on the other hand, the time spent in copying from Mark Twain seemed, in the main, a trifle shorter than the same ten-minute interval filled with copying nonsense syllables, and still shorter—though even here the difference is not great—than the same period occupied in copying dry material.

As regards ages, the results do not seem to warrant positive statements, since the variations are not consistent enough to justify conclusions.

The comparative amount of over- and underestimation, again, does not seem to justify fixed conclusions as regards the sexes. For the 'dry material,' the over- and underestimation were substantially the same; and though in copying

nonsense syllables the underestimation of the men was markedly greater, when copying from 'Huckleberry Finn,' on the other hand, the amount of underestimation of the women was the greater. Further, while in listening to 'Huckleberry Finn' the overestimation of both men and women was greatly emphasized, the sex difference was not sufficient to warrant distinctions.

The percentages of correct estimates for the ten minute periods, again, do not seem to justify conclusions based on ages. We might be inclined to stress the larger percentages of correct estimates in the older men and women were it not for the equally correct estimates scattered among the younger students. In all four instances, however, copying 'dry material,' nonsense syllables, 'Huckleberry Finn,' and in listening to 'Huckleberry Finn' the general average of correct estimates is greater for the women than for the men.

For both the men and women the underestimation of time spent in copying nonsense syllables is greater than the underestimation in copying dry sense material. And for the men, the underestimation of time spent in copying from 'Huckleberry Finn,' while less than for copying nonsense syllables is greater than the underestimation of the same period spent in copying dry sense material. In other words, so far as conclusions are warranted from this investigation, ten minutes filled with copying from one of the most humorous incidents in Mark Twain's 'Huckleberry Finn' seem longer for both men and women than the same amount of time spent in copying dry sense material. Further, when compared with the estimate of ten minutes occupied in copying nonsense syllables, the same time spent in copying 'Huckleberry Finn,' while thought to be longer by the men was, again, estimated slightly shorter by the women.

Summary

The 30 sec., 1 min., 2 min., and 5 min. periods both filled and empty are overestimated by men and women irrespective of ages.

There seems to be no consistent difference between empty

time of these periods and the same intervals filled with copying uninteresting material from the engineering catalogue.

The general average of correct estimates, in percentages, for these periods, both filled and empty, is greater for women than for men.

In the ten-minute period, variously filled, both men and women underestimated the time when they were copying either interesting or uninteresting material. Copying one of 'Huckleberry Finn's' cleverest escapades had no more effect than copying dry sense material or nonsense syllables. All, alike resulted in underestimation of the time, with copying nonsense syllables leading for the men.

But both men and women, on the other hand, overestimated the same period of time when they were listening to one of Mark Twain's humorous stories. It may be said, therefore, that when the subject is doing something, even if the task is uninteresting, time seems shorter than when spent in listening to an interesting story.

But here, as in the case of the shorter periods, the general average of correct estimates is a little better for the women than for the men.

We, therefore, seem justified in saying that, under the conditions of this investigation, women have a slightly more correct feeling for time than men have.